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FEBRUARY, 1879.

I. "PROGRESS,"

THE ALLEGED DISTINCTION BETWEEN MAN AND BRUTE.

IS man essentially progressive? Are all other animals as essentially stationary? The public opinion of these latter days and a number of eminent writers answer both these questions in the affirmative, trusting to find here the long-sought "great gulf."

To man they ascribe a threefold movement—of the individual, of the community, and of the species. To brutes they ascribe immobility. Disregarding the charge of "cynicism" which may perhaps be brought against us, we shall examine a portion at least of these assertions. We shall make bold to ask whether it is really true, as so often asserted, that man is from the cradle to the grave a "progressive being," still able and willing to learn, and to improve even to the very last? Do his views as he grows older become continually freer and wider, his insights deeper, and his prejudices feebler? The notion can scarcely be fairly and fully stated without revealing its utter absurdity. It is one of those errors which men assert in general terms, and yet deny daily in words as well as actions. Every observer of human nature, every man of experience, admits that the mind, like the body, up to a certain period increases in its powers, and afterwards gradually declines. Like the body, it becomes first less flexible, and then feebler. Figuratively speaking it is ossified. The epoch of this change varies not a little in different individuals. Yet in almost every man there comes a time when he ceases to grow mentally just as he has ceased to grow corporeally—when he no

longer looks forward; losing at once the power and the desire to observe new facts and evolve new theories, or even to recognise them if discovered by others. He becomes stagnant, and instead of the bold "plus ultra" of his prime he feebly murmurs "Rest and be thankful."

It is stated that not a single physician who had reached the age of forty, prior to the announcement of Harvey's discovery of the circulation of the blood, could ever be brought to recognise it as correct. World-betterers of all shades, moral and religious reformers who are labouring at the difficult task of improving man, continually bear testimony that "it is of little use attempting to elevate or amend the adults; we must turn our attention mainly to the children." In so saying they substantially admit our position. There are, indeed, men of vast and highly-cultivated intelligence, who, up to an advanced age, and even to the very close of their days, seem to go on thinking and discovering, to long for new truths, and to weigh every novel theory with candour and impartiality. But these are the very exceptions which prove the rule. Their biographers do not fail to point out this persistent energy of the mind as a proof of their exceptional nature and of their superiority to ordinary men.

Nor must we forget that many of the discoveries and other great works, emanating apparently from men far advanced in life, have in reality been wrought out in their earlier days, though the publication of the results, especially in a popular form, has been delayed. The power of expression, too, as a rule, survives by many years the power of origination.

But what of the normal average man? Is he not from the middle of life, and often indeed from an earlier date, a mere bundle of habits and prejudices? His interest in anything not immediately relating to self—where it ever existed—has dwindled. His mind has lost its suggestiveness. He shrinks from change of place, scene, and occupation. He dislikes new associates. He suspects new views, and imputes motives to their promulgators. With him, just as with the lower animals, no further mental growth is possible, however long he may happen to survive.

The truth here put forward has recently received full demonstration—if such were needed—at the hands of an American man of science, Dr. G. M. Baird. In his treatise* he shows that 70 per cent of the work of the world

* Legal Responsibility in Old Age.

is done before 45, and 80 per cent before 50. "The golden decade of a man's life (the interval between his thirtieth and fortieth year) alone represents nearly one-third of the work of the world. The advantage of the period from 20 to 30 over that from 50 to 60 is very striking, and will cause surprise."

In short, from a careful biographical examination, it fully appears that in the individual man—so far at least as his present life is concerned—there is no indefinite and continued progress. His powers of body and mind are developed together, and simultaneously—or nearly so—they decline. The same law applies to him as to the lower animals, and, if we take into account the different term of life of each species, all have their "golden epoch" about the same part of their career.

To man, then, brutes exhibit no well-marked contrast, but a decided similarity. In the earlier part of life they are, like ourselves, capable of progress; they observe, learn, and retain facts, and to a certain extent they draw conclusions from such observations. By-and-bye their faculties are blunted, and, like man, they become stationary. That in them stagnation may set in somewhat earlier than it does in civilised man is not impossible. But this is a mere difference of degree, not of kind. It is very easy for the rhetorician to exclaim—"The brute soon attains a degree of perfection which he can never surpass, and were he to live a thousand years he would still be the same." This is no less exact a portrait of the human species than of the gorilla, the dog, or the ant. As far, then, as individual progress is concerned, man and beast differ merely in degree.

There is also among mankind a national or tribal progress distinct from that of the individual and that of the species, but, like them both, not unlimited in its extent and duration. Historians tell us how a small community has, if unchecked by hostile circumstances, grown up into a great empire, and how, again, it has declined and come to ruin. For such national decay they assign a variety of causes, according to their political and social prepossessions. In one case the calamity is ascribed to luxury; in another, to the toleration of slavery or of usury; in others, to the importation of foreign-grown corn, to the non-recognition of "woman's rights," or to the existence of vivisection, and other the like springs, which to examine would be a departure from our purpose. But whatever share of blame may attach to such causes, we should seek for the main source of the evil in the

decay of that which in a nation corresponds to vitality in the individual,—that is to say, of the so-called "tribal instinct." When this instinct gives place either to avowed selfishness or to cosmopolitanism—and the two differ really more in seeming than in being—the doom of the nation is sealed, despite alike of its resources and its virtues.

Among those animal species which live in organised communities or nations the very same phenomenon occurs; increase and rise are followed by decline and fall. Every ant-hill might have its Gibbon. This fact has been fully established by the illustrious French chemist M. Berthelot, who for the last quarter of a century has devoted much of his leisure to a study of the manners of ants.* He noticed in particular a very prosperous ant-hill, which had established roads in all directions of more than 100 metres in length. After about ten years it sent out a colony which established itself at the root of a young oak at some little distance, and though feeble in the outset increased year by year, and passed safely through a very critical epoch, the periodical felling of the wood. The observations of M. Berthelot were temporarily interrupted by the war. On resuming his studies he found, to his surprise, the colony in full prosperity, but the mother-city declining. Its population had lessened, and continued so to do, and the survivors neglected their habitations. The former colony now takes the lead, and its new buildings and well-kept roads contrast strangely with the crumbling structures of the old formicary, which, however, is still inhabited.

We have ourselves observed a very similar case among rooks. An old and populous rookery from no apparent cause dwindled away, whilst a colony which it had founded in its early days gradually surpassed the mother-city, and became in turn the rook-capital of the district. Surely, then, we must admit that the cities and nations of brutes, like those of mankind, have their origin, their progress, and their decline. Here therefore, again, instead of contrast we find resemblance.

We turn now to what is in popular literature more generally known as "progress"—the real or fancied superiority of every generation of mankind over the foregoing. But this very superiority, though assumed in after-dinner speeches and in songs of the "good time coming" type, is a matter of most grave question. Even as regards knowledge and power, the advance which some claim as a

* Correspondance Scientifique, Oct. 1, 1878.

characteristic feature of humanity is effected by exceptional individuals who arise in certain races under favourable circumstances only, and is quite compatible with long intervals of immobility, and even of decline. Can a property so rare and fluctuating be made an essential point in any definition of man, or can it be used to establish a "great gulf" between him and the brute creation?

Further, it is nowise proved that the lower animals are literally incapable of progress. Our acquaintance with the habits and powers of most brute species, incomplete even at the present day, is far too recent to justify such an assumption. On the other hand, cases are not wanting which can scarcely be regarded in any other light than as inventions made, *e.g.*, by ants. Thus, from a work recently noticed in the "Quarterly Journal of Science,"* we quote the following incident recorded by Prof. Gredler, of Boston:—"One of his colleagues had for months been in the habit of sprinkling pounded sugar on the sill of his window, for a train of ants which passed in constant procession from the garden to the window. One day he took it into his head to put the pounded sugar into a vessel which he fastened with a string to the transom of the window, and, in order that his long-petted insects might have information of the supply suspended above, a number of the same set of ants were placed with the sugar in the vessel. These busy creatures forthwith seized on the particles of sugar, and soon discovering the only way open to them—viz., up the string, over the transom, and down the window-frame—rejoined their fellows on the sill, whence they could resume the old route down the wall into the garden. Before long the route over the new track, from the sill to the sugar by the window-frame, transom, and string, was completely established, and so passed a day or two without anything new. Then one morning it was noticed that the ants were stopping at their old place, the window-sill, and again getting sugar there. Not a single individual any longer traversed the path that led thence to the sugar above. This was not because the store above had been exhausted, but because some dozen little fellows were working away vigorously and incessantly up aloft in the vessel, dragging the sugar-crumbs to its edge, and throwing them down to their comrades below on the sill—a sill which, with their limited range of vision, they could not possibly see."

This is indisputably an instance of invention, and as all

* Flowers and their Unbidden Guests, p. 21.

man's progress in the industrial arts, in power, whether destructive or constructive, is ultimately due to invention, the alleged stationariness of the lower animals as compared with man can no longer be maintained.

II. MATTER DEAD.

"Elementa sunt facta de Yle."—ROGER BACON.

LET us suppose Roger Bacon to be a good representative of the philosophy that matter is one, and John Dalton as representing belief in the primordial diversity of atoms, and let each have a modern mouthpiece. We can imagine the following:—

Roger Bacon—I have read in a German book something like this: Give me an atom, and I make the world, life and thought included. This was not writing of the highest class there, but it was from observing the tone of the writing of some of the most talented men, and I certainly think it not quite unfair to draw such conclusions as the writer drew after imbibing for truth the thoughts of the most prominent men. Have I not seen, also, in the writings of one of the men considered first in rank, and certainly by himself as first in importance, that the finest feelings of the soul are all dependent on a certain fluid which we are left to suppose produces them.

To the first observation there is a short reply, and if any man founds his philosophy on such a supposed knowledge of the action of atoms he can gain confidence only from the most ignorant or the most illogical. We do not know how any atom acts, and the assertion is simply akin to the sayings of Baron Munchausen.

If to the second observation any one gives trust, he may be correct in a sense, as we may say no conscious thought occurs in man without water; but if any man will say that he knows why any certain substance, liquid or solid, acts in producing thought, he is a visionary, and does not belong to the class of sound scientific men: him also I put on my shelves with the boasting Baron. And yet how many men there are who suppose that these things are actually known,

whilst there are some who speak amongst us as if they knew them. Men assert the power of matter who have not to themselves clearly defined what matter is. Most men, even scientific men, speak as if it were only the substances known to us in chemistry as "the elements." Some will allow both elements and forces, or ponderable and imponderable matter, the imponderable acting as forces; but it is probably the opinion most prevalent that matter and force are one. To use the words of one of the most recent volumes, by a scientific man of careful thought,—"Wherever matter exists, energy (either potential or active) also exists (or matter is the seat of energy)—is another truth of the widest kind, based upon universal experience, and is inferred from the fact that energy has never been observed except in connection with matter; *i.e.*, in connection with that which possesses weight."

John Dalton—We cast the seeds into the earth, and they grow, collecting matter willingly, whilst matter readily flows to them. A tree grows, and we throw it into the fire; it acts with violence, and matter again collects about it and carries off all that had been so laboriously brought together. Surely matter is alive.

Is not the world in a constant state of motion itself, whilst its surface is restless, and much of it extremely agitated? Surely, too, every element is vigorous, scarcely any to be found in freedom, all attached servilely to some other, and by constant changings keeping up the proof of vitality. This world is far apart from other worlds, and yet it keeps in constant communication with them and shows its sympathy, which can only exist because of its life.

The elements in many cases cling violently to each other, and combination is accompanied by burning heat, which heat again goes to set other bodies in motion. Matter is therefore not only powerful, but it is a reservoir of power.

So active is matter that if it is freed from the violence of cohesive enchainment, as in a state of gas, every particle raves continually, and is in eternal wildest motion as constantly as the moving planets, if not so carefully regulated in every step. Here is eternal motion; here is an atom with an evident endowment of eternal life. If it has that now, must its eternity not have existed in the past also?

Indeed so full of activity is matter, that even when atoms are in combination and are apparently at rest, in the centre even of the everlasting hills, they are for ever revolving or in agitation in their very limited sphere.

Roger Bacon—Is all this true? This system has brought

about no true definition. So far as I can understand, most if not all the life is held to be in the definite atom; so far as many are concerned it certainly is. It has been supposed that there is one common atom as well as one substance; but it has been said that the atom possesses always more or less motion, due, it is assumed, "to a primordial impulse. This motion gives rise to volume; the more rapid the motion the greater the space occupied by the atom."

Let us look at the elements, and see if all is true. The metals are certainly not much inclined to combine amongst themselves. Mercury will attack some; but freeze it, and it is as quiet as the others, whilst soft metals are deadened by a similar treatment.

John Dalton—True the metals are cold-blooded, and require a hot climate to live in; but give them warmth, and you see another result. Even without warming them, put them to a cool liquid; platinum itself will give way before acids.

Roger Bacon—Yes, but freeze the acids, and I fear we come to the well-known saying, "Corpora non agunt nisi soluta."

John Dalton—But why trouble yourself with these frozen bodies? Take hydrogen and chlorine on the coldest day, and let them but get a glimpse of the sun, and they burst out with a joy unknown even to the violence of our youth. There we see the activity of elements.

Roger Bacon—True, but freeze your chlorine, not difficult to do; freeze your hydrogen into such a solid that it falls like a pebble on the floor. I fear they will have no joyful shout, but will not deign to recognise each other, even if the pieces are in apparent contact.

Nay more, take all the elements that you have in the world and freeze them to solids, throw them into a heap together as large as you please, and is it not almost certain from our not perfect knowledge that the action will be simply nothing. The elements are dead, the matter we see is dead, the matter concerning which men speak is dead. Here is an end; let that be left in peace.

John Dalton—That is easily granted if there is no warmth, but add only a small amount of heat to this mass of elements and will you not light up the whole? give even a little corner the light of a match and this will cause a combination, and this will produce heat, and this heat will warm up the next portion, and like a fire of the richest coal the whole will burn and spread heat to all around.

Here is the inherent power of the atom; it was not dead—it slept.

Roger Bacon—If so, what has become of the eternal motion of your atoms? what has become of the motion of your gases? what has become of the independent life of your matter? What power is in these masses to grow trees and thinking men? I thought you admired the theories of Lucretius, who tells us of the "primordia rerum," the very beginning of things moving gradually into complexity and evolving worlds and life. He was the earliest of the evolutionists whose system is well known to us, and he has many followers who somewhat modify his views. I thought you admired the self-initiating vortices by which are made all worlds, and the beautiful nebular theory of Laplace and of moderns now making worlds busily by this atomic eternal activity.

John Dalton—Not exactly. Moderns require heat, and heat itself is produced by atomic action, so that the action is enough after all.

Roger Bacon—Heat is motion. I thought it was agreed that the atoms would not move by themselves.

But as you require something more I will give it you. Indeed I will give you as much heat as you please near this corner, where you proposed to set the bulk on fire. Let there be a piece of any of our elements glowing white placed near. If heat is motion there must be something to move. By what means will this heat communicate motion to the elements?

John Dalton—Heat passes in a few minutes from us to the sun, and your small bundle of elements would soon absorb all you could send.

Roger Bacon—True it may be that heat passes to us rapidly, through space, but if it is only motion it must pass on something movable. Can you imagine it passing through empty space? Men used to think so when heat was to them a solid, but now there must be a something that is put into agitation. If your elements were quite alone they could not be fired; they must have that which we call ether, simply because it is so thin compared with our usual matter.

I will go farther. Even if your elements in combining produced heat, that heat would not be given out; to what place would it go? It could not go into empty space. What motion can there be in emptiness; can there be motion in nothingness? Your great fire would burn out, and the force would not be preserved. The waves would be lost for want

of the sea; or it would be a dash against an immovable shore, from which too there was no rebound.

I may even go farther still. Let us suppose some of the elements heated: I doubt if this heat could be communicated to the others. I do not know that an atom can touch an atom; if not the heat could not be communicated through the empty space. This ether, unknown as it is, may be required to bridge over the same distance between atom and atom. Where, then, is the force of your atom and its power of life? To live it requires the aid of a something only beginning to be recognised as matter, and the ingenious Lucretius and all similar thinkers to this day have speculated on an empty supposition. We have seen that our matter is dead unless it has heat, that heat cannot be conveyed to it unless by means of a something that we must suppose to exist, but whose existence is unintelligible to us, and which has none of the properties usually assigned to matter. Moreover, even if this something is allowed to exist in abundance it cannot give heat, but can only convey it.

John Dalton—I am willing to concede the ether as matter and the heat as motion; then I think we have all the preparation for the heat which you require.

Roger Bacon—If you concede the ether as matter you go before many physicists and chemists. You observe the quotation I made from a very recent book that matter is that which possesses weight. I never heard of the ether gravitating. You concede then the point that the elements known to chemists do not show any activity or vitality of themselves, and they must be warmed before they act. You allow that the elements have not initiated chemical activity, and that is a great concession, and I think it only an honest one demanded by the known facts. You allow that we must bring in motion from the exterior. You allow that when we have it in any amount it will never reach the elements, however near, unless the ether intervene. You allow also, I think, that even the motion of heat will in all probability not pass from molecule to molecule, let us say, or our present chemical atoms. Surely then it is not far wrong to say of our elements, regarding them as the total matter of the universe; matter is dead.

III. A CONTRIBUTION TO THE HISTORY OF ELECTRIC LIGHTING.

By W. Mattieu Williams, F.C.S., F.R.A.S.

As the subject of lighting by electricity is occupying so much public attention, and the merits of various inventors and inventions are so keenly discussed, the following facts may have some historical interest in connection with it.

In October, 1845, I was consulted by some American gentlemen concerning the construction of a large voltaic battery for experimenting upon an invention, afterwards described and published in the specification of "King's Patent Electric Light" (Letters Patent granted for Scotland, November 26, 1845; enrolled March 25, 1846).

Mr. King was not the inventor, but he and Mr. Dorr supplied capital, and Mr. Snyder also held a share, which was afterwards transferred to myself. The inventor was Mr. Starr, a young man about 25 years of age, and one of the ablest experimental investigators with whom I have ever had the privilege of near acquaintance.

He had been working for some years on the subject, commencing with the ordinary arc between charcoal points. His first efforts were directed to maintaining constancy, and he showed me, in January of 1846, an arrangement by which he succeeded in effecting an automatic renewal of contact by means of an electro-magnet, the armature of which received the electric flow, when the arc was broken, and which thus magnetised brought the carbons together and then allowed them to be withdrawn to their required separation, when the flow returned. This device was almost identical with that subsequently re-invented and patented by Mr. Staite (quite independently I believe), and which, with modifications, has since been rather extensively used.

Although successful so far, he was not satisfied. He reasoned out the subject, and concluded that the electric spark between metals, the electric arc between the carbons, and other luminous electric phenomena are secondary efforts due to the heating and illumination of electric carriers; that the electric spark of the conductors of ordinary electrical machines is simply a transfer of incandescent particles of

metal, which effect a kind of electric convection, known as the disruptive discharge; and that the more brilliant arc between the carbon points is simply due to the use of a substance which breaks up more readily, and gives a longer, broader, and more continuous stream of incandescent convection particles.

This is now readily accepted, but at that time was only dawning upon the understanding of electricians. I am satisfied that Mr. Starr worked out the principle quite originally. He therefore concluded that, the light being due to solid particles heated by electric disturbance, it would be more advantageous—as regards steadiness, economy, and simplicity—to place in the current a continuous solid barrier, which should present sufficient resistance to its passage to become bodily incandescent without disruption.

This was the essence of the invention specified in King's Patent as "a communication from abroad," which claims the use of continuous metallic and carbon conductors, intensely heated by the passage of a current of electricity, for the purposes of illumination.

The metal selected was platinum, which, as the specification states, "though not so infusible as iridium, has but little affinity for oxygen, and offers a great resistance to the passage of the current." The form of thin sheets known by the name of leaf-platinum is described as preferable. These to be rolled between sheets of copper in order to secure uniformity, and to be carefully cut in strips of equal width, and with a clean edge, in order that one part may not be fused before the other parts have obtained a sufficiently high temperature to produce a brilliant light. This strip to be suspended between forceps.

I need not describe the arrangement for regulating the distance between the forceps, for directing the current, &c., as we soon learned that this part of the invention was of no practical value, on account of the narrow margin between efficient incandescence and the fusion of the platinum. The experiments with the large battery that I made—consisting of 100 Daniell cells, with 2 square feet of working surface of each element in each cell, and the copper-plates about $\frac{3}{4}$ of an inch distant from the zinc—satisfied all concerned that neither platinum nor any available alloy of platinum and iridium could be relied upon; especially when the grand idea of subdividing the light by interposing several platinum strips in the same circuit, and working with a proportionally high power, was carried out.

This drove Mr. Starr to rely upon the second part of the specification, viz., that of using a small stick of carbon made incandescent in a Torricellian vacuum. He commenced with plumbago, and, after trying many other forms of carbon, found that which lines gas-retorts that have been long in use was the best.

The carbon stick of square section, about one-tenth of an inch thick and half an inch working length, was held vertically, by metallic forceps at each end, in a barometer tube, the upper part of which, containing the carbon, was enlarged to a sort of oblong bulb. A thick platinum wire from the upper forceps was sealed into the top of the tube and projected beyond; a similar wire passed downwards from the lower forceps, and dipped into the mercury of the tube, which was so long that when arranged as a barometer the enlarged end containing the carbon was vacuous.

Considerable difficulty was at first encountered in supporting this fragile stick. Metallic supports were not available, on account of their expansion; and, finally, little cylinders of porcelain were used, one on each side of the carbon stick, and about three-eighths of an inch distant.

By connecting the mercury cup with one terminal of the battery, and the upper platinum-wire with the other, a brilliant and perfectly steady light was produced, not so intense as the ordinary disruption arc between carbons, but equally if not more effective, on account of the magnitude of brilliant radiating surface.

Some curious phenomena accompanied this illumination of the carbon. The mercury column fell to about half its barometric height, and presently the glass opposite the carbon stick became slightly dimmed by the deposition of a thin film of sooty deposit.

At first the depression of the mercury was attributed to the formation of mercurial vapour, and is described accordingly in the specification; but further observation refuted this theory, for no return of the mercury took place when the tube was cooled. The depression was permanent. The formation of vaporous carbon was suggested by one of the capitalists; but neither Mr. Starr nor myself was satisfied with this, nor with any other surmise we were able to make during Mr. Starr's lifetime, nor up to the period of final abandonment of the enterprise.

When this occurred the remaining apparatus was assigned to me, and I retained possession of the finally arranged tube and carbon for many years, and have shown it in action worked by a small Grove's battery in the Town Hall of

Birmingham, and many times to my pupils at the Birmingham and Midland Institute.

These exhibitions suggested an explanation of the mysterious gaseous matter, which I believe to be the correct one, and also of the carbon deposit. It is this:—That the carbon contains occluded oxygen; that when the carbon is heated some of this oxygen combines with the carbon, forming carbonic oxide and carbonic acid, and a little smoke. I proved the presence of carbonic acid by the usual tests, but did not quantitatively determine its proportion of the total atmosphere.

If I were fitting up another tube on this principle I should wash it with a strong solution of caustic potash before filling with mercury, and allow some of the potash solution to float on the mercury surface, by filling the tube while the glass remained moistened with the solution. My object would be to get rid of the carbonic acid as soon as formed, as the observations I have made lead me to believe that—when the carbon stick is incandescent in an atmosphere of carbonic acid or carbonic oxide—a certain degree of dissociation and re-combination is continually occurring, which weakens and would ultimately break up the carbon stick, and increases the sooty deposit.

The large battery above described was arranged for intensity, but even then it was found that the quantity (I use the old-fashioned terms) of electricity was excessive, and that it worked more advantageously when the cells were but partially filled with acid and sulphate. A larger stick of carbon might have been used with the whole surface in full action.

After working the battery in various ways, and duly considering the merits of the other forms of battery then in use, Mr. Starr was driven to the conclusion that for the purposes of practical illumination the voltaic battery was a hopeless source of power, and that magneto-electric machinery driven by steam-power must be used. I fully concurred with him in this conclusion, so did Mr. King, Mr. Dorr, and all concerned.

Mr. Starr then set to work to devise a suitable dynamo-electric machine, and, following his usual course of starting from first principles, concluded that all the armatures hitherto constructed were defective in one fundamental element of their arrangement. The thick copper-wire surrounding the soft iron core necessarily follows a spiral course, like that of a coarse screw-thread; but the electric current or lines of force which it is designed to pick up and carry circulate

at right angles to the axis of the core, and extend to some distance beyond its surface. The problem thus presented is to wind around the soft iron a conductor that shall be broad enough to grasp a large proportion of this outspread force, and yet shall follow its course as nearly as possible by standing out at right angles to the axis of the armature. This he proposed to effect by using a core of square section, and winding round it a broad ribbon of sheet copper, insulated on both sides by cementing on its surfaces a layer of silk ribbon. This armature to be laid with one edge against one side of the core, and carried on thus to the angle; then turned over so that its opposite edge should be presented to the next side of the core; this side to be followed in like manner, the ribbon similarly turned again at the next corner, and so on till the core becomes fully enclosed or armed with the continuous ribbon, which would thus encircle the core with its edges outwards, and nearly at right angles to the axis, in spite of its width, which might be increased to any extent found by experiment to be desirable.

At this stage my direct co-operation and confidential communication with Mr. Starr ceased, as I remained in London while he went to Birmingham in order to get his machinery constructed, and to apply it at the works of Messrs. Elkington, who had then recently introduced the principle of dynamo-electric motive-power, electro-plating, &c., and were, I believe, using Woolrich's apparatus, the patent for which was dated August 1, 1842, and enrolled February 1, 1843.

I am unable to state the results of his efforts in Birmingham. I only heard the murmurs of the capitalists, who loudly complained of expenditure without results. They had dreamed the same dream that Mr. Edison has recently re-dreamed, and has told the world so loudly. They supposed that the mechanically excited current might be carried along great lengths of wire, and the carbons interposed where required, and that the same electricity would flow on and do the duty of illumination over and over again, as a river may fall over a succession of weirs and turn water-wheels at each. Mr. Starr knew better; his scepticism was misinterpreted; he was taunted with failure and non-fulfilment of the anticipations he had raised, and with the fruitless expenditure of large sums of other people's money. He was a high-minded, honourable, and very sensitive man, suffering already from overworked brain before he went to Birmingham. There he worked again still harder, with further vexation and disappointment, until one morning he

was found dead in his bed. Having, during my short acquaintance with him, enjoyed his full confidence in reference to all his investigations, both completed and incomplete, I have no hesitation in affirming that his early death cut short the career of one who otherwise would have largely contributed to the progress of experimental science, and have done honour to his country. His martyrdom, for such it was, taught me an useful lesson I then much needed, viz., to abstain from entering upon a costly series of physical investigations without being well assured of the means of completing them, and, above all, of being able to afford to fail.

There are many others who sorely need to be impressed with the same lesson, especially at this moment and in connection with this subject.

The warning is the most applicable to those who are now misled by a plausible but false analogy. They look at the progress made in other things, the mighty achievements of modern Science, and therefore infer that the electric light—even though unsuccessful hitherto—may be improved up to practical success, as other things have been. A great fallacy is hidden here. As a matter of fact the progress made in electric lighting since Mr. Starr's death, thirty-one years ago, has been very small indeed. As regards the lamp itself no progress whatever has been made. I am satisfied that Starr's continuous carbon stick, properly managed in a true vacuum, or an atmosphere free from oxygen, carbonic oxide, carbonic acid, or other oxygen compound, is the best that has yet been placed before the public for all purposes where exceptionally intense illumination (as in lighthouses) is not demanded. It is the steadiest, the cheapest, and least glaring in proportion to the amount of light it radiates. It has not been "pushed" like other devices, simply because it is nobody's exclusive property.

Comparing electric with gas lighting, the hopeful believers in progressive improvement appear to forget that gas making and gas lighting are as susceptible of further improvement as electric lighting, and that, as a matter of fact, its practical progress during the last forty years is incomparably greater than that of the electric light. I refer more particularly to the practical and crucial question of economy. The by-products, the ammoniacal salts, the liquid hydrocarbons, and their derivatives, have been developed into so many useful forms by the achievements of modern chemistry, that these, with the coke, are of sufficient value to cover the whole cost of manufacture, and leave the gas itself as a volatile residuum that costs nothing. It would actually and

practically cost nothing, and might be profitably delivered to the burners of gas consumers (of far better quality than now supplied in London) at one shilling per thousand cubic feet, if gas making were conducted on sound commercial principles,—that is, if it were not a corporate monopoly, and were subject to the wholesome stimulating influence of free competition and private enterprise. As it is, our gas and the price we pay for it are absurdities; and all calculations respecting the comparative cost of new methods of illumination should be based not on what we *do* pay per candle-power of gas-light, but what we *ought* to pay and *should* pay if the gas companies were subjected to desirable competition, or visited with the national confiscation I consider they deserve.

Having had considerable practical experience in the commercial distillation of coal for the sake of its liquid and solid hydrocarbons, I speak thus plainly and with full confidence.

There is yet another consideration, and one of vital importance, to be taken into account, viz., that—whether we use the electric light derived from a dynamo-electric source, or coal-gas—our primary source of illuminating power is coal, or rather the chemical energy derivable from the combination of its hydrogen and carbon with oxygen. Now this chemical energy is a limited quantity, and the progress of Science can no more increase this quantity than it can make a ton of coal weigh 21 cwts. by increasing the quantity of its gravitating energy.

The demonstrable limit of scientific possibilities is the economical application of this limited store of energy, by converting it into the demanded form of force without waste. The more indirect and roundabout the method of application, the greater must be the loss of power in the course of its transfer and conversion. In heating the boiler that sets the dynamo-electric machine to work, about one-half the energy of the coal is wasted, even with the best constructed furnaces. This merely as regards the quantity of water evaporated. In converting the heat force into mechanical power—raising the piston, &c., of the steam-engine—this working half is again seriously reduced. In further converting this residuum of mechanical power into electrical energy, a further and considerable loss is suffered in originating and sustaining the motion of the dynamo-electric machine, in the dissipation of the electric energy that the armature cannot pick up, and in overcoming the electrical resistances to its transfer.

I am unable to state the amount of this loss in trustworthy figures, but should be very much surprised to learn that, with the best arrangements now known, more than one-tenth of the original energy of the coal is made practically available. This small illuminating residuum may, and doubtless will, be increased by the progress of practical improvement; but, from the necessary nature of the problem, the power available for illumination at the end of the series must always be but a small portion of that employed at the beginning.

In burning the gas derived from coal we obtain its illuminating power *directly*, and if we burn it properly we obtain nearly all. The coke residuum is also directly used as a source of heat. The chief waste of the original energy in the gas-works is represented by that portion of the coke that is burned under the retorts, and in obtaining the relatively small amount of steam-power demanded in the works. These are far more than paid for by the value of the liquid hydrocarbons and the ammonia salts, when they are properly utilised.

In concluding my narrative I may add that after Mr. Starr's death the patentees offered to engage me on certain terms to carry on his work. I declined this, simply because I had seen enough to convince me of the impossibility of any success at all corresponding to their anticipations. During the intervening thirty years I have abstained from further meddling with the electric light, because all that I had seen then, and have heard of since, has convinced me that—although as a scientific achievement the electric light is a splendid success—its practical application to all purposes where cost is a matter of serious consideration is a complete and hopeless failure, and must of necessity continue to be so.

Whoever can afford to pay some shillings per hour for a single splendid light of solar completeness can have it without difficulty, but not so where the cost in pence per hour per burner have to be counted.

I should add that before the publication of King's specification, Mr. (now Sir William) Grove proposed the use of a helix or coil of platinum, made incandescent by electricity, as a light to be used for certain purposes. This was shown at the Royal Society on or about December 1st, 1845.

IV. THE PROBLEM OF FLIGHT: BALLOONING IN ARCTIC EXPLORATION.

THE proposal to employ balloons in Arctic Exploration has recently attracted more general attention to the hitherto unsolved problem of artificial flight. The methodical study of the laws of natural flight, which has been pursued for several years by Dr. Pettigrew, Prof. Marey, and M. Dupuy de Lome, has cleared up many disputed points. The researches of these gentlemen have already been fully described and illustrated in the "Journal of Science." Our object in again directing the attention of our readers to the subject is not therefore to refer to their labours, but to give a brief account of the more recent experiments of Mr. Brearey, the indefatigable Secretary of the London Aëronautical Society. Mr. Brearey has been studying the subject for some years, and has communicated to the Society the results he has obtained, illustrating his paper by models the bird-like action of which becomes, as Mr. Glaisher remarked, very interesting when we consider that it is produced by mechanism. By following up these experiments our knowledge of the subject must of necessity be largely increased, if the problem of flight be not actually solved.

Mr. Brearey first illustrated flight by means of models projected by the hand. The first experiment demonstrated flight by gravity alone, showing how the bat, hanging by its claws, by simply releasing itself attains its first flight.

Then he showed how the application of force neutralises the force of gravity. In this model the screw propelled a plane surface, which was represented by wings. It was made after the model of M. Penaud, of the French Aëronautical Society, improved as to the screw by Mr. Brearey.

To show that different forms of surface may be employed with instructive results for future work, the author in the next model adapted the albatross form of wing, the model being about half the length, viz., 7 feet, but the breadth being only one-fourth, or 2 inches, that of the albatross being about 8 inches.

This class of experiment may be greatly varied with a view to ascertain the weight which can be carried under a given surface. According to Mr. Brearey the angle of in-

clination with which the wing advances will have to be increased with the weight, and also the force in the same relative proportion.

It is asserted by some naturalists, in explanation of effective wing action, that the feathers of a bird's wing are made to underlap each other, so that in the downward stroke the pressure of the air closes them upwards against each other, and converts the whole series into one connected membrane, through which there is no escape; whilst in the upward stroke the same pressure has precisely the reverse effect. "It opens the feathers," says the Duke of Argyll, "separates them from each other, and converts each pair of feathers into a self-acting valve through which the air rushes at every point." The Duke, in his "Reign of Law," remarks Mr. Brearey, so thoroughly recognises, in another place, the immense importance of the concave and convex surfaces in gripping the air in the one case and evading it in the other, that he can scarcely lay much stress upon the valvular system of feathers. Dr. Pettigrew, whose researches give weight to his statement, estimates this difference as two to one.

To show that in the wing propeller the convex and concave arrangement is most effective, Mr. Brearey stood upon a pivoted stool, and holding the artificial wing perfectly level, waved it up and down, by which action he was caused to revolve.

He then proceeded to the practical application of the concave-convex theory by exhibiting a model after the construction of M. Penaud, of the French Society.

Experimenting with various forms of wings, he has been enabled to imitate the leisurely flight of the crow and the swift flight of the swallow. Mr. Brearey also made some observations upon the vertical screw, again resorting to M. Penaud's Helicoptère in illustration.

Passing to the question of the use of balloons in Polar Exploration, the author remarked that the balloon has a sphere of its own quite independent of its shape, unapproachable by any other invention, and the question for discussion is—Was the late Polar Expedition such an opportunity as afforded any reasonable chance for the useful employment of the balloon?

This question can never be fairly answered unless a balloon, with the necessary means for its inflation, form part of the vessel's equipment.

All the materials and apparatus being conveyed to the place of destination, there should be no difficulty in the

inflation. Giffard's balloon, exhibited in 1869 at Cremorne, was inflated with pure hydrogen, and could carry upwards of 16 tons.

The balloon successfully inflated, then what would be the work expected from it?

Instead of a seventy days' journey, to accomplish about 70 miles, at a fearful cost of life and suffering consequent upon having to drag over ice hummocks sledges containing provisions, as described in the Arctic Report, Mr. Brearey argues that the whole of the stores could have been conveyed over the heads of the explorers, and the men holding the ropes of this floating observatory would have been assisted by the upward tendency of the balloon. The question is—Would the daily consumption of stores compensate the leakage of gas? Major Beaumont, in his history of the Balloon as employed in the American War, says "that the balloon when inflated can, unless in very windy weather, be very readily carried. Twenty-five or thirty men lay hold of cords attached to the ring and march along, allowing the machine to rise only sufficiently to clear any obstacle. He had frequently," he says, "seen it carried thus without the least difficulty." He further says "that there was always a small amount of leakage, but, from the superiority of the varnish, at the end of a fortnight, sufficient gas remained in the balloon to enable an ascent to be made without its being replenished." The ascensive power of a balloon thus conveyed for purposes of war must be available at any moment for the two observers, and the additional weight of the two guy ropes which it also has to sustain, so that the necessity for the twenty-five or thirty men is explained; but for the purposes of exploration and the carrying of stores a very few pounds of ascensional force need be requisite. These stores, however, upon being removed from the balloon; or the sledges, which might be partly buoyed by the balloon, being detached; could not the balloon then be utilised to survey the country from some thousand feet or more by means of a let-out cord?

An interesting discussion followed the reading of Mr. Brearey's paper, in the course of which Mr. Reece remarked that there would be no fear of the efficacy of hydrogen. After it was generated it would pass through ice, or would be so cold that it would maintain the same temperature throughout the journey. Hydrogen gas would be generated at a heat of 180°. It would then pass through a tube and be chilled, and would remain at a temperature of about 32°, so that there would be no fear of its depositing a mass of

snow or ice. Mansfield, in his work on ballooning, suggested that the weight of a man might be taken off by ballooning. A balloon of 18 feet diameter would take off the weight of a man; and in this way a man named Ward was able to leap in the forest, from tree to tree, with a velocity of 15 miles an hour. In this case a man might guide a sledge of dogs at a great pace, and could convey stores by this means to any point.

With regard to the nature of hydrogen gas in a severe frost, Mr. Reece said he had submitted the gas to intense cold, and it appeared to have no effect upon it. Faraday exposed it to cold 100° below zero and a pressure of 800 atmospheres, and never found that either had the slightest effect upon it; neither had the most intense cold or pressure that he could produce at the Royal Institution.

Mr. Simmons remarked that the hot-air balloon seemed to be the best adapted to the especial object—

1. Because in the presence of intense cold, wind does not exist, wind being the chief drawback to the inflation of hot-air balloons in England. (Mr. Simmons's experience in this matter was confined to Canada; he had not visited the Arctic Regions.)
2. Because the more intense the cold of the air surrounding the balloon, the greater the ascending power.
3. The hot-air balloon during inflation will give off sufficient heat from its surface to keep the men warm whilst they are holding the net, and when the balloon is afloat no inconvenience can be experienced from cold.
4. The time required for the inflation of the hot-air balloon is about half-an-hour, and the preparation of the apparatus for the inflation will never be found so troublesome or occupy so much time as that for the hydrogen balloon.
5. The danger and annoyance from carrying oil of vitriol will be obviated.
6. Hot-air balloons have no preparation spread upon their surfaces that can sustain any injury, decomposition, or spontaneous combustion from being closely packed for a lengthened period.

The entire weight of the balloon apparatus used at the Royal Arsenal, Woolwich, was 1200 lbs., its diameter was 70 feet, and the heat when inflated, taken 10 feet above the open neck of the balloon, was 120° F.

The greatest difficulty against the inflation of a balloon with pure hydrogen gas in intensely cold regions would, in

Mr. Simmons's opinion, be the keeping of the water in the retort from freezing whilst charging or after being charged with water, until the vitriol is poured in. The process of making pure hydrogen gas by means of furnaces would necessitate the employment of exceedingly cumbersome apparatus.

Mr. Reece, alluding to the formation of hydrogen, remarked that, according to Sir George Nares, the average temperature during the Expedition in the Arctic Regions was 30° F. That would not have the slightest effect on a composition of 1 part sulphuric acid and 4 parts water. When poured on zinc the temperature would rise to 180°. If anyone tried that in a glass vessel he could not keep his hand on it, so that any fear of not generating the gas must be entirely visionary. Air expands only one 480th part for each degree, so that great heat would be required for an air balloon. A fire balloon had enormous power, but nothing like one filled with hydrogen gas.

Mr. Simmons remarked that the heat generated in a hot-air balloon would be 120°. The weight of a balloon and all its paraphernalia might be 1200 lbs., the diameter 70 feet, and it would carry a man into the air if the average heat were 120°.

Mr. Glaisher, in thanking Mr. Brearey for his paper, observed that in the late Arctic Expedition everything was excluded that was possible to be excluded on account of the want of room. If a balloon of 70 feet diameter had to be taken out, a very large space would be required. Again, it could only be used in summer time, when there is wind in the Arctic Regions. In Russia and Sweden in winter time, when the temperature approaches zero, it is nearly always calm. To realise the intensity of the cold one must move the hand against the cold air or run against the air. No person standing in an atmosphere 70° below zero would feel that the cold was so intense. It might be far more painful when the temperature was above zero if the air were in motion; but the winter was not the time when these experiments would be made: they would take place in the summer, when the temperature would be 40°, and in the sun very much hotter. He (Mr. Glaisher) saw no reason, however, why the balloon should not be made available in various ways in Arctic Exploration, and he hoped that if there was another Expedition the balloon would be tried and the question settled. It would certainly, if used in connection with a sledge, enable the distance that could be traversed in the day to be increased. With regard to the view that

could be obtained from the balloon: when he was half a mile over London he could see Margate and Brighton, and on to the Norfolk coast. This showed how much may be seen from a comparatively small elevation. From the height of a mile he could see nearly 90 miles, and even when a few hundred feet high one was in a position to see over the country for several miles ahead. In any case he hoped that in the next Expedition, from whatever country it may proceed, not only one balloon but several balloons would be taken out.

V. ELECTRIC LIGHTING BY INCANDESCENCE.

To determine the Electromotive Force required to maintain a rod of a given material, of given dimensions, at a given temperature, when loss of heat by radiation, convection, and conduction are taken into account.

By Prof. W. E. Ayrton.

HAVING found it necessary to solve the above question in connection with the possibility of economically illuminating, by a material rendered incandescent with the electric arc (the system employed by Edison, Wedermann, Sawyer-Man, &c., and *first* patented in England by De Moleyns in 1841, and not, as commonly supposed, by King, since his patent bears the date of 1845), I have thought that the results obtained may be generally interesting.

The problem of the flow of heat through a bar from which there is loss of heat by radiation and convection has, since the time of Fourier, been often treated; the mathematical investigation was employed by Forbes in his experiments made to determine whether the heat conductivity of iron, like the electric conductivity, varied with the temperature, and exactly similar equations have been made use of in studying the passage of an electric current through a wire from all points of which there is leakage, as in an ordinary submarine cable, and especially in a submarine cable made of inferior gutta-percha. The problem, however, we have on the present occasion to deal with differs from the preceding in that there is, at every point, not only loss of heat by conduction, radiation, and convection, but, in addition,

a generation of heat due to the resistance opposed to the passage of the electric current.

The method of solution that must be employed consists in first calculating the amount of heat that will be lost per second by conduction, convection, and radiation in each very small section of the bar, as well as the amount generated per second by the electric current in the same section. Then, when the temperature of the bar has settled down into a constant state, that is when the temperature of any one point does not vary from second to second (although the temperature of different points of the bar may be very different at the same time), the total loss and the total generation of heat per second in any one section must be equal. This equality leads to a differential equation, the solution of which is an exponential formula, connecting the strength of the current required with the temperature of the middle point of the wire, its dimensions, specific resistance, heat conductivity, and surface emissivity.

In order to apply this formula to the two very important cases of illuminating by an incandescent platinum wire, or by an incandescent carbon rod, it is necessary to know the surface emissivity, or heat radiating power, of the substance of our incandescent wire.

Now probably no experiments have yet been made to determine the *absolute* loss of heat per unit of surface from a body of a given temperature when the difference of temperature between the heated surface and the walls of the room exceeds 100 or 200 degrees centigrade. And, in fact, when this difference is even less than 100 degrees the *accurate* information at our disposal is scanty. Fortunately, however, the law of radiation of heat is such that unless there is a total discontinuity in the phenomenon as the temperature rises we are enabled to make a very good rough estimate of what this absolute amount of radiation must be, even at very high temperatures, such as that of white-hot charcoal.

Formerly, it was thought that Newton's law of cooling, viz.:—that the rate of loss was simply proportional to the excess of temperature, was correct; next the experiments of MM. Dulong and Petit seemed to show that in a vacuum the rate of loss was proportional to $m\ 1{\cdot}0077_\theta\ (1{\cdot}0077^t - 1)$ where m is a constant depending on the radiating surface, θ the temperature of the enclosure, and t the excess of temperature of the hot body; while those of Mr. Hopkins led to the result that the loss by the convective action *alone* of the gas in which the heated body was placed was proportional

to $m\,p_a\,t^{1\cdot233}$ where m and a depend on the nature of the gas at a pressure p, and t, as before, is the excess of temperature.

The preceding formulæ do not, however, give results agreeing well with more recent experiments. In the "Proceedings of the Royal Society" for 1872, Mr. McFarlane published the results of his experiments on the absolute amount of radiation and convection from a polished and from a blackened copper ball in air. In addition to the fact that these experiments were made probably under the eye of Sir William Thomson, to whom Mr. McFarlane is an assistant, and that, therefore, they are probably correct, I have verified them experimentally myself, and extended them to other gases than air, and at various pressures.*

Mr. McFarlane's experiments show that the measured surface emissivity increases *less* and *less* rapidly as the difference of temperature rises. Probably, therefore, we may be safe in saying that for a difference of temperature of 1000° C. (about the temperature of melting cast-iron), the value for platinum and carbon will not be very much higher than the highest he obtained, respectively, for polished and for blackened copper.

From experiments made in a vacuum, I find that when the difference of temperature is under 100° C. the value of the surface emissivity is about half, and for gases like coal-gas about double that obtained by Mr. McFarlane in damp air at ordinary pressure.

In some of the systems of electric lighting it has been proposed to enclose the incandescent rod in a vacuum, in others in some non-decomposable gas, like nitrogen. In this latter gas I have not hitherto made absolute radiation and convection experiments, but we may fairly take as a mean value of this surface emissivity the air value previously referred to.

The specific electric resistance of platinum is a comparatively constant quantity, while that for carbon varies within wide limits. It, therefore, becomes an important question to determine what kind of carbon, that which conducts electricity pretty well, or that which is a much worse conductor, is the more suitable to be used for illumination by incandescence. Now the temperature equation previously referred to, shows that for a given electromotive force maintained at the two ends of a carbon rod, the smaller be the specific resistance of the carbon employed, the greater will be the heat, and, consequently, temperature produced.

* The results of these experiments of Professor Perry and myself will shortly be published.

Of course, this is on the assumption that the heat conductivity does not vary with the electric conductivity, and this seems to a certain extent to be the case, since, while we find the electric conductivity of carbon varying between very wide limits, the heat conductivity, as far as results of experiments are available, seems to be much more constant.

At first sight it might appear inconsistent with ordinary experience to say that for a carbon rod of given dimensions the smaller the specific resistance the greater the quantity of heat developed, but it must be remembered that here we are considering a *constant electromotive force* applied at the two ends of the rod, whereas in ordinary practice it is a *constant current* we have to deal with, since when even a Grove's battery is employed to produce the current through a *short continuous* rod of carbon, the chief resistance is in the battery itself, so that the current is practically independent of changes of resistance in the carbon.

Consequently, for this investigation, it is better to employ a form of carbon opposing a low resistance, than one offering a high resistance to the passage of the current.

Substituting in our equation the known values of the heat conductivity, &c., of platinum and carbon, we arrive at the result that if our incandescent wire be about No. 20, Birmingham wire gauge, or have a diameter of about one millimetre, and if its length be five centimetres in the case of the platinum and two in the case of the carbon (this longer length in the first instance being necessary on account of the better conducting power of the platinum), then the electromotive force necessary to be maintained at the two ends of the wire is—

0·2848 volts, or roughly one-third of that of a Daniell's cell, in the case of the platinum, and

0·46013 volts, or roughly one-half that of a Daniell's cell, in the case of the carbon wire.

It is, therefore, quite possible to produce a light with an electromotive force far less than that of a single Daniell's cell, but not, of course, with a Daniell's cell itself, since the resistance of this would be incomparably greater than that of our incandescent rod or wire.

Although it requires 50 per cent more electromotive force to maintain the centre of our two-centimetre rod of carbon at 1000° C. than it does to maintain the centre of our five-centimetre length of equally thick platinum wire at the same temperature, it is probable that the shorter carbon rod would give out more light—first, because, in consequence of the inferior heat conductivity of carbon, the temperature curve

would be flatter in the middle and steeper at the ends, so that the "surface integral" of the temperature would be higher in the case of the carbon than for the platinum; secondly, because a substance like carbon, which is black when illuminated by an extraneous light, gives out more light than a bright substance like platinum, at the same temperature, when sufficiently heated to become self-luminous; a phenomenon easily tried by placing in the flame of a spirit lamp a piece of platinum foil on which a black spot has been made with Indian ink.

In the preceding investigation no reference has been made to the value of the specific heat of the substance rendered incandescent; and reflection will show that, if a continuous light be required, the specific heat can (contrary to what has been often said) have nothing to do with the question; for, if the electric current only produces per second as much heat as will be lost per second by radiation, convection, and conduction after the body has reached a temperature of 1000° C., then it must necessarily reach this temperature, since at all lower temperatures it will gain more heat than it loses.

If, however, instead of a constant light, it were, for any purpose, desired that a rapid succession of lightings and extinguishing of the lamp should be possible, then, undoubtedly, it would be well to employ, for the incandescent rod, a substance having a small specific heat.

I found it not difficult, in 1873, when designing, at the request of the Government, an electric lamp for the use of the divers who recovered the property sunk in the French Mail steamer *Nil* off the coast of Japan, to make such thin carbon wires as I have spoken of in this paper. The process I employed was first to scrape an ordinary carbon rod very thin, then fix it to the two electrodes inside a glass globe from which the air could be exhausted. A strong electric current was now passed through the rod, which was burnt to the required degree of thinness by the air pumped through the globe. The current was then stopped, the air pump out, and replaced by nitrogen, when the globe was sealed up.

Another plan I employed, on account of the fragile nature of very thin carbon, was to use platinum wire coated with carbon, and rendered incandescent in an atmosphere of nitrogen, but it was difficult to prevent the carbon coming off the smooth platinum wire.

VI. INSTINCT OR REASON?*

HERE we wish to place on record a narrative of a most singular occurrence witnessed by the writer and a friend while hunting ducks at Bean's Lake, in Platte County, Missouri. It will be found a most vivid illustration of the wonderful intelligence of a bird whose habits of solitary life have kept it beyond the ordinary observation of men.

While sitting behind a "blind," over our decoys, waiting for game, on the 3rd day of April, 1875, we saw, at the distance of a mile toward the west end of the lake, a large number of huge white birds, and, watching them curiously, finally discovered that they were coming toward us on the water—a host. In an hour the mass was abreast of us, and proved to be made up of pelicans, a band we estimated to be 60 feet in width and 300 feet long closely packed together, each one touching his neighbours on all sides. It appeared as though a foot-ball could not have fallen to the water at any point on the band. They moved as a raft might move with a slow current—no motive power visible, each one maintaining his place without flutter or struggle. Moreover, they were unlike swan or geese in that their heads were not raised, being drawn backward and laid upon the back between the wings, while the long mandibles lay forward, flat upon the neck. Not a sound or a motion from an individual; only the still, solemn glide of the entire raft. And yet there were many thousands of them. Allowing a foot in width and a foot and half in length for each bird, there were twelve thousand pelicans before us. They passed on to the lower end of the lake, then almost immediately rose and flew back over us, and settled again in the shoal water. While flying the pelican shows the broad black band on the extreme feathers of the wings, and would be a very beautiful bird, but it does not stretch forth the neck, even while flying, thus appearing like a swan with his head cut off—*very awkward*. During the day this vast multitude was joined by scores of large flocks, which came down from the sky, circling down in narrow spirals from a height from which they could not be seen. Whence did they come? What was the object of the meeting? Who was the messenger that had called this horde together? They must

* From an artlcle by ERMINE CASE, Jun., in the Kansas City Review.

have gathered from all the corners of the earth; for by extensive inquiry made since that day among those most likely to know, no witness has been found who ever saw more than fifty together, in one place in this region. All day long they moved slowly about the upper end of the lake, and only occasionally did small groups fly about or splash in the water. A great and solemn convention was evidently being held. Toward evening, however, we saw more commotion among them, and, desiring to witness more closely this wonderful gathering, we went up the lake toward them. After quietly approaching within a half mile of the nearest, we saw that a general motion was being made in our direction, whereupon we concealed ourselves close to the edge of the water, and from thence during the next hour witnessed the most amazing pageant of our lives.

The number had clearly doubled since morning, and the entire troop were arranged in line and engaged in a movement the object of which we could not at first make out. The line was some 300 yards in extent, and at least thirty birds in depth—all "dressed" to the left (continuing the military figure), and at that wing resting upon the bank from which the line slightly diverged, at the extreme right being some 30 yards out; the general movement being toward the shore. As the birds on the left reached the land, they immediately rose in the air and passed back of the line, and formed again on the extreme right. In this way probably five hundred birds were flying at a time, and by this method of deploying from the left to the right wing the grand army was being rapidly moved toward us. When quite near and before us we easily saw that the object of this advance in order of battle was not mere dress parade—each bird was rapidly dashing his head under water, bringing up fish. This long line, then, was a seine fastened to the bank at the left, and being gradually drawn toward the shore, driving the finny prey into the shallow water, where it was incontinently swallowed by the living meshes of this enormous net. Nothing could be of more thrilling interest than to witness the intelligence with which this enormous flock carried out every detail to success. Several times we noticed a detachment, as if detailed for special duty, swing around over some deeper pool, flying so as to drag their feet and flap the extremities of their wings upon the water, closing in finally at the open end of the net on the right. Had a skiff load of boys been sent out with poles to splash the water and drive in the fish, the manœuvre could not have been plainer in its object than was the one before us.

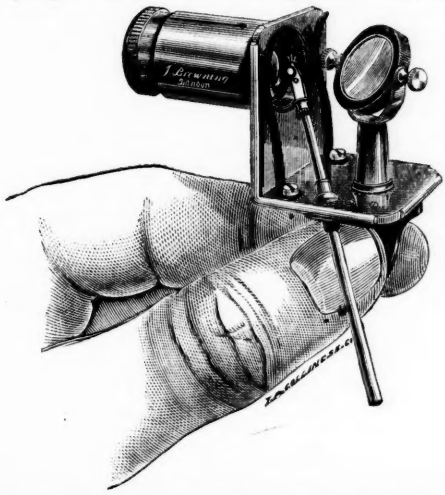
Why should one flying group "drive" in this way, while other scores passed regularly on to their places? Where was the commander-in-chief? There was no struggle for precedence, no fighting, no pressing out of line; here was a voiceless, disciplined multitude, intelligently carrying out an elaborate plan.

When the line had advanced, and lay within 30 feet of us, we rose quickly and fired our guns over them; and when this myriad rose, utterly filling the air, the broad wings crashed against one another with the roar of a hundred trains. Thus closed this most wonderful spectacle.

A specimen we obtained measured 9½ feet from tip to tip of the wings. The mandibles were 15 inches long, and the pouch held 2 quarts of wheat.

VII. COMPOUND ACHROMATIC MICROSCOPE.

MR. JOHN BROWNING has constructed a compound achromatic microscope of extremely small dimensions, the actual size being represented in the accompanying woodcut. The two powers magnify respect-



ively about 15 and 35 diameters: the highest power is provided with a lieberkuhn for the illumination of opaque

objects, which may be held in the forceps, or, if suitably mounted with black spot, examined on the ordinary 3 × 1 slide, for holding which a spring clip is provided. A little practice with the mirror will enable great variety in illumination to be obtained. The definition is remarkably good, showing the markings of some of the coarser diatoms, such as Arachnoidiscus and Isthmia, and will prove useful as a demonstration microscope, as it can easily be passed from hand to hand with little chance of the adjustments becoming deranged. It will be also very useful to those who, from unsteadiness of hand, are unable to use a lens of tolerably high power, as no amount of tremor can interfere with its definition, and when packed in its case it can easily be carried in the waistcoat-pocket.

Mr. Zentmayer has contrived a stage for his new microscope which has virtually *no thickness whatever*. By placing the slide below the stage instead of above, as usual, every impediment to employment of illuminating pencils of extreme obliquity is done away with. The object is secured beneath the stage by a pair of spring clips. The whole of this very simple contrivance can be removed at pleasure, and the usual stage substituted when required.

VIII. SAFE ANÆSTHESIA.

THE dangers attending the administration of chloroform as an anæsthetic agent have always been a source of great anxiety to surgical operators; but while many other so-called safe anæsthetic agents have from time to time been proposed, it has hitherto been impossible to omit chloroform from its position as the only practical anæsthetic in surgical operations of a protracted nature. It will, however, be a source of great gratification to the whole of the members of the medical profession to know that the subject is under investigation, and that a competent committee are endeavouring not only to discover wherein the special dangers of chloroform consist, but also to discover if some anæsthetic agent can be found which will avoid these dangers. The Committee of the British Medical Association, consisting of Dr. Coats, Pathologist to the Western Infirmary, Glasgow; Dr. Ramsay, Assistant to the Professor of Chemistry; and

Dr. McKendrick, Professor of Physiology in the University of Glasgow, have already issued two reports, abstracts of which we propose to lay before our readers:—

In studying the question of the effects of chloroform on the respiration and the heart, it soon became apparent to the committee that chloroform administered to dogs and rabbits has a disastrous effect on the respiratory centres; it is easy to kill one of these animals by pushing the chloroform till respiration is paralysed. In observing the state of the heart during these experiments, it could often be determined by auscultation that its contractions were maintained after respiration had ceased. It was apparent, however, that, even when failure of respiration was more directly the cause of death, the heart was to some extent simultaneously affected; and there were even cases in which the heart appeared to fail at least as soon as, if not before, the breathing. Considering these facts, and bearing in mind that failure of the heart is often asserted in the reports of death from chloroform, a method of experimentation was devised by which respiration would be eliminated, and the effects of chloroform on the heart observed apart from that complication.

In the frog the movements of respiration are not necessary to life, so far as the heart is concerned, as that organ continues beating long after these movements have ceased. After exposing this animal to the vapour of chloroform under an inverted jar until it was anæsthetised, it was found that the heart became rapidly weaker, till it ceased beating, but with ether the heart continued vigorously beating as long as the experiment was continued.

A method was now devised for warm-blooded animals, such as rabbits and dogs. It was found that chloroform immediately produces a serious effect on the heart; the right ventricle almost immediately begins to distend, and the heart presently stops with the right ventricle engorged with blood. In the case of rabbits the heart often virtually came to a standstill within a minute of the introduction of chloroform. Ether may, however, be given under the same conditions for an indefinite period without interfering with the heart. Artificial respiration with ether was maintained in the circuit for an hour, and at the end of that time the heart was beating as vigorously as at first.

In this respect, therefore, ether possesses an enormous advantage over chloroform, but ether has the great disadvantage of tardiness of action. In comparative experiments with rabbits, in which the anæsthetics were given on a towel, it appeared that with chloroform complete anæsthesia was

produced in about three minutes, while in the case of ether it took fifteen to twenty minutes, although the cloth was kept saturated. The committee therefore endeavoured to find an agent which should be as potent as an anæsthetic as chloroform, yet affect the heart and respiration as little as ether.

Whatever substitute for chloroform is found it must be one which can be administered in large doses, and in trying the following agents the committee administered full doses.

Benzine (C_6H_6) was used with the frog. Its effects were nearly as slow as those of ether, and it produced struggling; weakening of the heart was apparent, but not so great as with chloroform.

Acetone (C_3H_6O) produced only slight anæsthesia in the frog, even after prolonged administration.

Pyrrol (C_4H_5N) produced anæsthesia in the frog with considerably less rapidity than chloroform, but great excitement and muscular spasms took place before complete anæsthesia. Administered to three young rabbits subcutaneously, it produced convulsive movements, chiefly of the jaws and fore paws. Anæsthesia in these rabbits was doubtful.

So-called bichloride of methylene, the reputed formula of which is CH_2Cl_2, on being administered to frogs, it was found that the heart became quickly affected, and soon stopped. With rabbits, respiration rapidly deteriorated and stopped while the heart was still beating. In an experiment with artificial respiration the heart was weakened and soon stopped, but not as rapidly as with chloroform. As in the case of chloroform, the right ventricle became enormously distended—the first sign of paralysis being the commencement of this distension.

Amylene (C_5H_{10}) was administered to rabbits both by cloth and subcutaneously. No anæsthetic effect was produced.

Butyl chloride (C_4H_9Cl) administered to rabbits affected respiration, but not very rapidly. In experiments with exposure of the heart, the cardiac pulsations became weaker, and ceased altogether after some time. In one experiment, it was noted that, almost immediately after complete anæsthesia, the respiration became shallow and soon stopped.

Ethene dichloride, formerly named ethylene dichloride, or Dutch liquid ($C_2H_4Cl_2$) produced convulsive movements of both extremities, continuing up to death. There was no anæsthesia up to the commencement of the convulsions.

Methyl chloride (CH_3Cl), which boils at the ordinary temperature, was obtained in alcoholic solution in a sealed tube, and allowed to boil off into a funnel, into which the muzzle of a rabbit was inserted. After somewhat prolonged use, there was not any abolition of reflex action, and the animal almost immediately recovered. The only effect was slight drowsiness.

Ethyl chloride (C_2H_5Cl) boiling at 12 deg. C. = 53·6 deg. Fahr., administered to rabbits in the same way as the above, produced rapid anæsthesia; but in one case the respirations soon stopped, and in another, when air was admitted more freely, general convulsions occurred.

Nitrous ethyl ether ($C_2H_5NO_2$) produced great excitement and convulsions, almost immediately followed by cessation of respiration.

It is obvious that none of these substances would take the place of chloroform, but the committee experimented with isobutyl chloride and ethidene dichloride, with which they obtained comparatively successful results. They thus describe their experiments with these agents:—

Isobutyl chloride (C_5H_9Cl).—1. Experiments on the frog. When it was administered under a glass jar, complete anæsthesia occurred in about five minutes. The heart was observed for thirty-five minutes, during which period its contractions were perfectly vigorous.

2. Experiments on rabbits. When it was administered with a cloth, anæsthesia was produced in three to five minutes. It was continued after anæsthesia for nearly half-an-hour without any interference with respiration.—3. Experiments on dogs. It was administered on cloth; anæsthesia was produced in four minutes. It was continued for half-an-hour, and respiration was unaffected, except slight occasional stertor.

Ethidene dichloride ($C_2H_4Cl_2$, an isomeride of ethene-dichloride, produced from aldehyde). The committee have administered dichloride of ethidene to six patients in the Western Infirmary of Glasgow, with most satisfactory results. The first case was that of a young man aged eighteen, who had an abscess opened near the hip-joint. The anæsthetic was given at 9.19 a.m.; at 9.27, there was complete anæsthesia; the operation began at 9.29, and was completed at 9.32, the patient waking up at 9.35. The recovery was rapid, and there was no vomiting, sickness, or headache. About half an ounce of the substance was used.

In the second case a girl aged thirteen was operated upon, who had abscesses in the thigh, from spinal disease. One

abscess pointed towards the outer aspect of the thigh, while another was more in front. The opening of the first was the special operation at this time. The notes record that, before administration of the anæsthetic, the pulse was 134. At 9.47 the anæsthetic was given, and at 9.50 the pulse had fallen to 120; at 9.54 it was 100, and at 9.55 anæsthesia and muscular relaxation were complete. At 9.56½, there was vomiting, which was undoubtedly caused by the patient having had food in the morning, contrary to orders. The operation was over at 10.1, and at 10.3 the patient was recovering. At 10.5½, she was able to answer intelligently. The amount used was three drachms and a half.

Case III. was a girl aged eight. The operation was removal of the forefinger for strumous disease of bone. At the beginning the pulse was 120; in one minute and a half, it had fallen to 110; in two and a half, to 105; in five, to 102; in six and a half, to 100; and in seven minutes anæsthesia was complete. At eight minutes and a half from the time the anæsthetic was given, the breathing became slightly stertorous. At the end of fourteen minutes, the operation was over, and the pulse was 105. The patient recovered from the anæsthetic, so as to answer questions, in about two minutes, and there was no headache, sickness, or vomiting afterwards.

Case IV. was the same patient as in No. 2. The abscess in front of the thigh previously alluded to was opened. At 9.9 a.m., before the anæsthetic was given, the pulse was 140; at 9.10½, it had fallen to 110; at 9.12, it was at 104; at 9.13, there was slight flushing of the face; at 9.14, the pulse was 100, and there was slight stertor; and at 9.15 there was complete relaxation and absence of reflex movements. The operation was quickly over; at 9.22, the pulse was 110; at 9.23, consciousness had returned; and at 9.24, the pulse had risen to 130. The amount used was four drachms.

Case V. was that of a very powerful young man, aged twenty-one, who was operated upon for the radical cure of inguinal hernia. Immediately before giving the anæsthetic, the pulse was very rapid from excitement—about 140. At 9.17, the anæsthetic was given; at 9.18½, the pulse had fallen to 110; at 9.22, pulse 110 and slight struggling; at 9.23, it was observed that the face was slightly flushed; at 9.24 and 9.26, considerable struggling; at 9.28 the pulse had fallen to 74, and the operation was commenced; at 9.35, pulse 70, and respirations deep and regular; at 9.40, the operation was over, and at 9.42 consciousness returned. About 9.41, there was deep anæsthesia and complete

muscular relaxation; a condition specially necessary for such an operation. The amount used was an ounce and a quarter.

In ase VI. a little girl aged eight had several pieces of diseased bone removed from the ankle. The anæsthetic was given at 10.3½; at 10.5½, the patient was "over," and the operation was begun. After 10.10, no anæsthetic was given. She quickly recovered consciousness, when there was some retching. It appears that this girl had been ailing with sickness and occasional retching for several days previously. The amount used was about two drachms.

Such is a short record of the six cases observed by the committee. The features of special interest in these cases are the facts that there was no injurious effect observable on the respiratory mechanism, although in all cases the anæsthetic was given in such doses as to produce complete anæsthesia and muscular relaxation, and in one the patient was deeply under its influence for twenty-five minutes. 2. The pulse diminished in frequency and increased in volume, and in the deepest anæsthesia it was steady, regular, full, and compressible. There was no indication of failure of cardiac action in any case: a result anticipated from what had been previously observed in animals. 3. There was never any pallor of the countenance or blueness of the lips, but, on the contrary, and even during the deepest anæsthesia, there was a healthy flush on the face and the lips were rosy-red. Taking into account the change in the character of the pulse and in the colour of the face, it would appear that, in anæsthesia from dichloride of ethidene, the blood still remains in a normal amount in the arterial and capillary systems, and does not tend to engorge the venous system and right side of the heart, as is apparently the physiological action of chloroform.

The experiments on dogs show that a dog will live for a lengthened period in a state of complete anæsthesia under the influence of ethidene dichloride, whilst it will die in a short time when chloroform is used.

Attention is drawn to the fact, which is certainly remarkabe, that butyl chloride and isobutyl chloride, having the same chemical formula, exhibit such different actions. Ethene dichloride and ethidene dichloride are also isomeric, but the first of these produced severe convulsions, while the second promises to be an excellent anæsthetic without any convulsive effects.

Several curious effects, interesting especially from a psychological point of view, have been elicited with regard

to the effects of small doses of chloroform and ether on the rapidity of nervous and mental processes. By a refined method of experimenting with Regnault's chronograph, it was ascertained that a few respirations of air containing chloroform or ether produced remarkable retardation in the time of signalling back that a visual impression had been perceived, although the person operated on was quite unconscious of any such delay.

The committee are continuing their researches, and we shall look forward to the issue of their third report. There would seem to be little doubt of their finding an agent or agents which will partially, if not entirely, supersede chloroform as an anæsthetic.

Writing on this subject in the *British Medical Journal*, Mr. J. T. Clover, F.R.C.S., says that a few years ago he received a supply of the ethidene from Messrs. Schoelensack; and after using about half he put the remainder on the shelf, not finding it sufficiently better than chloroform to counterbalance the objections to introduce a new anæsthetic. He found that it produced sickness; and he was not so much impressed by its not seriously depressing the action of the heart, because he has found that chloroform in diluted doses rarely does so.

After reading the report, he found half a bottle (about eight ozs.) of his original stock left. The cork was as sound as if it had only just been put into the bottle, and the liquid was unaltered, thus affording proof of the stability of the substance. He has tried it again, and although probably it excites as much vomiting as chloroform, he is disposed to give it a further trial.

With regard to the remark of the committee that practically a dog will live for a lengthened period in a state of complete anæsthesia under the influence of ethidene dichloride, whilst it will die in a short time when chloroform is used, Mr. Clover suggests that the strength of the vapour of chloroform was greater than that of the ethidene, which would be greatly reduced in consequence of the coldness of the liquid produced by evaporation. He thinks a like failure of the heart might have happened if a fresh bottle of ethidene had been used instead of chloroform.

IX. ON THE TRANSMISSION OF POWER BY MEANS OF ELECTRICITY.

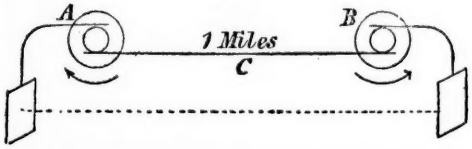
By Profs. ELIHU THOMSON and EDWIN J. HOUSTON.

THE statements recently made as to the size and cost of the cable that would be needed to convey the power of Niagara Falls to a distance of several hundred miles by electricity have induced the authors to write the present paper, in the hope that it may throw light upon this interesting subject.

As an example of some of the statements alluded to we may cite the following, viz., that made by a certain electrician, who asserts that the thickness of the cable required to convey the current that could be produced by the power of Niagara would require more copper than exists in the enormous deposits in the region of Lake Superior. Another statement estimates the cost of the cable at about 60 dollars per lineal foot.

As a matter of fact, however, the thickness of the cable required to convey such power is of no particular moment.

FIG. 1.



Indeed it is possible, should it be deemed desirable, to convey the total power of Niagara, *a distance of* 500 *miles or more, by a copper cable not exceeding one-half of an inch in thickness*. This, however, is an extreme case, and the exigencies of practical working would not require such restrictions as to size.

The following considerations will elucidate this matter:—Suppose two machines connected by a cable, of say 1 mile in length. One of these machines, as, for example, A, Fig. 1, is producing current by the expenditure of power; the other machine, B, used as an electrical motor, is producing power, by the current transmitted to it from A, by

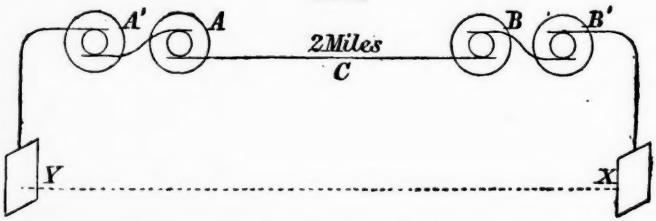
the cable C. The other terminals, x and y, are either put to earth or connected by a separate conductor.

Let us suppose that the electromotive force of the current which flows is unity. Since by the revolution of B, a counter-electromotive force is produced to that of A, the electromotive force of the current that flows is manifestly the difference of the two. Let the resistance of A and B together be equal to unity, and that of the mile of cable and connections between them the 0·01 of this unit. Then the current which flows will be—

$$C=\frac{E}{R}=\frac{1}{1\cdot01}.$$

If now an additional machine, A′, Fig. 2, an additional motor, B′, and an additional mile of cable, be introduced into the above circuit, the electromotive force will be

FIG. 2.



doubled, and the resistances will be doubled, the current strength remaining the same as—

$$C=\frac{E}{R}=\frac{1+1}{1\cdot01+1\cdot01}=\frac{2}{2\cdot02}.$$

Here it will be seen that the introduction of the two additional machines, A′, B′, has permitted the length of the cable, c, to be doubled, without increasing the strength of the current which flows, and yet allowing the expenditure of double the power at A A′ and a double recovery at B B′ of power, *or, in other words, a double transmission of power without increase of current.* Increase, now, the number of machines at A to say one thousand, and of those at B in like proportion, and the distance between them, or the length of the cable, one thousand, or in the case we have supposed, make it 1000 miles, its diameter remaining the same. Then although the same current will flow, yet *we have a thousand times the expenditure of power at one end of the cable, and a*

thousandfold recovery at the other end, without increase of current. And the same would be true for any other proportion.

Since the electromotive force is increased in proportion to the increase of power transmission, the insulation of the cable and machines would require to be proportionally increased.

As an example, it may be mentioned that a dynamo-electric machine used for the purpose of A in the figure, may have a resistance of say 40 ohms, and produce an electromotive force of say 40 volts. Such a machine might require from three to five horse-power when used in connection with a suitable motor, B, for recovery of the power transmitted.

If the resistance of the motor B be say 60 ohms, and the cable transmitting the currents a distance of 1 mile be 1 ohm, then the current—

$$C = \frac{400}{60+40+1} = \frac{400}{101}.$$

If, now, one thousand machines and one thousand motors, and a thousand miles of cable, each of the same relative resistances, be used, the current—

$$C = \frac{1000 \times 400}{1000 \times 101},$$

which has manifestly the same value as before. If our supposition of the power used to drive one machine be correct, then from 3000 to 5000 horse-power would be expended in driving the machines, and possibly about 50 per cent of this amount recovered. Then we have from 1500 to 2000 horse-power conveyed a distance of 1000 miles. What diameter of copper cable will be required for such transmission? Since this cable is supposed to have the resistance of 1 ohm to the mile, calculation would place the requisite thickness at about $\frac{1}{4}$ inch. If, however, the distance be only 500 miles, then the resistance per mile may be doubled, or the section of the cable be decreased one-half, or its diameter will be less than one-fifth of an inch.

For the consumption of 1,000,000 horse-power a cable of about 3 inches in diameter would suffice under the same conditions. However, by producing a much higher electromotive force, the section of the cable could be proportionally reduced, until the theoretical estimates which we have given in the first part of this paper might be fulfilled. The enormous electromotive force required in the above calculation would, however, necessitate such perfect insulation of the

cable that the practical limits might soon be reached. The amount of power required to be conveyed in any one direction would of course be dependent upon the uses that could be found for it, and it is hardly conceivable that any one locality could advantageously use the enormous supposed power we have referred to.

Stripped of its theoretical considerations, the important fact still remains that with a cable of very limited size an enormous quantity of power may be transferred to considerable distances. The burning of coal in the mines, and the conveyance of the power generated by the flow of rivers, may therefore be regarded as practicable, always, however, remembering that a loss of about 50 per cent will be almost unavoidable.

It may be mentioned that Dr. C. W. Siemens and Sir William Thomson have recently made statements that are in general accordance with the views here expressed.

NOTICES OF BOOKS.

Journal of a Tour in Morocco and the Great Atlas. By Joseph Dalton Hooker, Pres. R.S., and J. Ball, F.R.S. With an Appendix including a Sketch of the Geology of Morocco, by G. Maw, F.L.S., F.G.S. London: Macmillan and Co.

There is perhaps no country in existence so near to the centres of European civilisation, and yet so little known, as the empire of Morocco. Its geology, its flora and fauna, and even the main features of its physical geography, are to a very great degree uncertain. The higher interest, therefore, attaches to the explorations undertaken by the authors. The main object of the journey was of course botanical. It had long been the wish of Sir J. D. Hooker to explore the range of the Great Atlas, "up to that time little better known to geographers than it was in the time of Strabo and Pliny, and especially to find whether its vegetation formed a connecting-link between that of the Mediterranean region and the flora of the Canaries and Madeiras." For this task the authors were specially qualified by an acquaintance with the vegetation of Spain, Italy, Asia Minor, Syria, and Algeria. As an indispensable preliminary to travelling in such a region they had been furnished from the Foreign Office with a special recommendation to the Emperor, and they received every possible assistance from Sir J. Drummond Hay, at that time British Ambassador to the Moorish Court. Still their task was by no means easy. The provincial authorities received them, indeed, in deference to the Imperial mandate, with much courtesy, but at the same time showed no little suspicion, and were strongly desirous to prevent them from penetrating to the points they most desired to reach. The Moors, like many persons in our own country, cannot understand a man pursuing knowledge for its own sake. Hence the authors were obliged to represent themselves as searching for plants of medicinal value. Geological and mineralogical research could only be indulged in by stealth, as any one found breaking off fragments of stone is suspected of being a treasure-seeker. How a collector of animals would have to justify his actions to native curiosity is hard to imagine. In this department, however, the travellers do not appear to have taken any special interest. Indeed the fauna of North-western Africa is far from rich. Insect-life was found remarkably scarce, only one species of butterfly (*Papilio podalirius*) being mentioned. Locusts, however, were plentiful and destructive, though their ravages were by no means so indiscri-

minating as is often represented, certain plants escaping untouched. They are most greedy whilst still young, becoming sluggish when mature. If a swarm invades the fields before the middle of April, when the rainy season is not over, the plants that have been devoured almost down to the root revive with wonderful rapidity. If the swarms appear late, and attack the wheat or maize after it has flowered, the consequences are very serious. In combatting this evil the Moors would be greatly benefitted by the ingenious appliances lately devised for this purpose in the United States.

Certain of the serpents are said to be venomous, the bite of one species—not named—being reputed fatal in two minutes; but no case came under the observation of the travellers. In the Sous Valley, according to tradition, pythons of from 20 to 30 feet in length still lurk—descended doubtless from that monster which encountered the army of Regulus. Birds are not very numerous, but their fearlessness in presence of man is mentioned as an interesting fact.

The flora of Morocco, like its fauna, is far from showing that admixture of semi-tropical and tropical forms which might have been expected. The view of Mr. Wallace—that the Great Desert forms the northern boundary of the Ethiopian region, whilst the Mediterranean coast organically speaking pertains to Europe—appears to hold good in a botanical as well as in a zoological point of view. The Straits of Gibraltar must, however, have divided the two continents for a very considerable time, since, in spite of a general resemblance between the floras of Spain and of Morocco, each has a great number of distinct species. The connecting-links between the vegetation of the latter country and that of the Canaries are unimportant. Still these islands contain some peculiar forms more closely allied to endemic Moroccan species than to those of any other country. They contain also a large class of plants not hitherto found in Morocco, but more closely allied to Mediterranean forms than to any others. Hence Sir J. D. Hooker is disposed to regard these Atlantic islands "as a very distinct sub-region of the Mediterranean province.

The flora of Morocco, and secondarily its fauna, like those of many other countries, has suffered from fire-raising. The herdsmen, to obtain a fresh growth of grass for their cattle, set fire to the thickets, and in this manner the ancient forests of Mount Atlas have been gradually destroyed. A still worse enemy are the goats. Our authors most justly say—"The young plants while yet seedlings are cut off by the teeth of the goat, the great enemy of tree vegetation—an animal whose disastrous influence acting indirectly on the climate of wide regions entitles it to rank as one of the worst enemies of the human race."

The fertility of Morocco, were the land intelligently cultivated, would be prodigious. Even now the Aguidal garden at the city

of Morocco, a plot of about 40 acres, yields an average yearly return of £20,000.

The climate is remarkably genial and pleasant. The temperature fluctuates less than that of Madeira, the difference between the average temperature of the hottest and the coldest months not exceeding 10° F., whilst the number of rainy days at Mogador is only forty-five. Pulmonary affections are here all but unknown, and the region wants merely a settled Government to become an admirable sanitarium.

We regret that we must here cut short our notice of a work which literally teems with interesting facts. We can confidently recommend it to all who love accounts of travel, even if they are utterly unacquainted with botany.

The volume is tastefully got up, and is enriched with characteristic views of scenery, and with a map of Southern Morocco, corrected according to the observations of the travellers, and showing their route.

An Illustrated Dictionary of Scientific Terms. By WILLIAM ROSSITER. London and Glasgow: W. Collins, Sons, and Co. 1879.

MR. ROSSITER has tried to compress too large an amount of information into too small a compass, and in numerous instances he has sought for his definitions in untrustworthy directions, the consequence being that a number of words that are found every day in books and newspapers are of necessity omitted, while some of the explanations are calculated to mislead the student. Columbium is not a rare *mineral* found in columbite; coal brasses are not spathic ore; caviare is not a sauce; the papyrus is not a *tree* found on the banks of rivers; and soot is only in a very restricted sense "the unburnt remains of fuel." Had the generally useless cuts been left out Mr. Rossiter might have found room for such words as eosin, quantivalence, phonograph, microphone, &c. A large number of the words, too, are quite out of place in a dictionary of this kind. Surely it is not the office of a scientific dictionary to tell people the meaning of such words as bayonet, beet-root sugar, explosion, gable, language, and so on, all of which they can find in any sixpenny Johnson. This book is not at all worthy of a place by the side of many excellent scientific text-books issued by the same firm.

Coal; its History and Uses. By Professors GREEN, MIALL, THORPE, RUCKER, and MARSHALL, of the Yorkshire College. London: Macmillan and Co. 1878.

A SERIES of Ten Lectures delivered by the Professors of the Yorkshire College at Leeds and Keighley, in accordance with a suggestion made by Dr. Carpenter, the Secretary of the Gilchrist Educational Trust. These Lectures were afterwards revised, put together in a consecutive form, and illustrated with nearly sixty woodcuts. The subjects treated of are—the Geology of Coal by Prof. Green; Coal Plants and Animals, by Prof. Miall; the Chemistry of Coal, by Prof. Thorpe; on Coal as a Source of Warmth and Power, by Prof. Rücker; and, lastly, on the Coal Question, by Prof. Marshall.

Science made Easy. A Series of Ten Familiar Lectures on the Elements of Scientific Knowledge most required in Daily Life, &c. Parts I. to VI. By THOMAS TWINING, Author of "Technical Training." London: Hardwicke and Bogue.

THE first four parts of this work, which originally appeared in 1871, having speedily run out of print, Mr. Twining has taken the opportunity afforded him by the publication of Parts V. and VI. to thoroughly revise them, and bring down the knowledge contained in them to the present year by adding a postscript to the reprint of each of the four parts. The discoveries of MM. Pictet and Cailletet in relation to the liquefaction of oxygen, hydrogen, and nitrogen, De la Bastie's method of making toughened glass, and several others are noticed in their proper places. In other respects but little change has been made in the work. The last two parts contain four Lectures, entitled—A Glance at the Mineral Kingdom, with Notions concerning the Vegetable Kingdom; Outlines of the Animal Kingdom; and, lastly, a double Lecture on the Outlines of Human Physiology. The diagrams to this part of the work are drawn upon a black ground, which gives them an appearance of relief that is a very great help to the understanding. This is especially apparent in the diagrams relating to cell structure. The experiment was made by Mr. Twining in instituting Working Class Examinations in different parts of the country; and a programme is now issued yearly from the Economic Museum, Twickenham, giving full particulars of the regulations, certificates, and prizes, as well as the facilities offered to Institutions in the metropolis for the delivery of the Course. We are glad to see that Mr. Twining's praiseworthy and intelligent exertions in the cause of the spread

of scientific truth amongst the working classes are meeting with such success.

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. iv., No. 4. Washington: Government Printing-Office. 1878.

THIS issue contains Prof. S. H. Scudder's account of the fossil insects of the Green River shales, Wyoming. The bulk of the specimens found are damaged beyond recognition. The eighty species identified belong to six different orders of true insects, and have a decidedly tropical character.

Dr. S. Jordan reports on the collection of fishes made in Dakota and Montana by Dr. Elliott Coues, and Prof. Chickering gives a catalogue of 692 species of phanerogams and vascular cryptogams collected in the same territories. This document is of great value, from the light it throws upon the range of many plants.

Dr. Endlich's memoir, "On some Striking Products of Erosion in Colorado," is exceedingly instructive, and should be read by those—for such persons still exist—who fancy that the beds of rivers have been made not by them, but for them.

Mr. J. A. Allen contributes a paper on the *Sciuri*, or tree-squirrels, of America.

Records of the Geological Survey of India. Vol. xi., Part 3. 1878.

THIS issue contains an account of the progress of the Gold Industry in Wynad, in the Nilgiri district. Three companies have been at work for some time, not in the most scientific manner, but until recently the returns have not been very favourable. It is only within the last few months that some stone from "Wright's level," at the Alpha Works, has yielded from 11 to 17 dwts. per ton. From the latest reports of the working of the Prince of Wales' Company a rich vein has at length been struck.

Mr. F. R. Mallet describes a curious antimony ore from Sarawak, consisting partly of senarmontite.

Botany; Classification of Plants. By W. RAMSAY MCNAB, F.L.S. "The London Science Class-Books," edited by G. CAREY FOSTER, F.R.S., and P. MAGNUS, B.Sc. London: Longmans and Co.

IN this little manual compression seems to have reached, if not exceeded, its fair limit. Reversing the plan followed by Prof. McAlister in the companion volumes on zoology, the author devotes the larger portion of the space at his disposal to the lower forms of plant-life. Among the Thallophytes the families are characterised, whilst among phanerogamous plants they are simply enumerated without any reference to their distinctive features. In consequence the two portions of the book are of unequal value. There is a table of contents, but no index—an unfortunate deficiency, though inevitable from want of space.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditure, and Condition of the Institution for the Year 1877. Washington: Government Printing-Office.

THIS annual volume contains, in the first place, an account of the work done by the Institution and of its present position. The secretary, Mr. Jos. Henry, continues to urge, on what appear to us very valid grounds, the entire separation of the Institution from the National Museum of the United States. This latter establishment was formerly under the charge of the Patent Department, but was transferred to the Smithsonian Institution in 1858, whilst its importance fully warrants a distinct establishment. The Proceedings of the Smithsonian Institution and of the Museum are of course blended in the volume before us.

Amongst the most important work of the year we must mention Dr. Habel's "Archæological and Ethnological Researches in Central and South America." This gentleman, having taken Guatemala as a centre, devoted seven years to an exploration of the region, and afterwards visited Colombia, Ecuador, and Peru.

Nos. 7, 8, and 9 of the Bulletins of the Museum have also been published. The first of these is a valuable contribution to the natural history of the Hawaian and Fanning Islands, and of Lower California. No. 8 is an index to the hitherto very complex synonymy of the Brachiopoda, which rank among the most characteristic forms by which strata are co-ordinated.

Perhaps the most valuable part of the "Report" is the Appendix, which contains a profusion of valuable matter not

commonly to be met with. We find, in the first place, a full translation of Prof. Holmgren's memoir on colour-blindness—a subject which is now attracting general attention, from its bearing upon the correct interpretation of signals by railway officials and sailors. For the detection of this defect he gives a decided preference to Seebeck's method, an assortment of Berlin wools serving as test-objects. There is another interesting essay on the same subject, by Mr. Jos. Henry.

Next follow translations from the "Transactions of the Geneva Society of Physics and Natural History." There are, further, very valuable papers on the antiquities and ethnology of various parts of the Western Hemisphere; notes on the "History and Climate of New Mexico," in which that region, on the faith of a considerable body of statistical evidence, is recommended as a sanitarium for the consumptive. Dr. R. H. Coolidge is quoted as saying that "the worst possible climate for a consumptive is one with a long-continued high temperature and a high dew-point." Yet we have heard of not a few cases of incipient consumption where great benefit has been experienced from a residence in Sierra Leone.

Dr. Weismann's paper on the change of the Axoloth to an Amblystoma is given in full, together with an account of the experiments performed by Marie v. Chauvin.

The volume is completed by a number of short meteorological memoirs.

We notice in this "Report," as in former issues, a peculiarity which greatly detracts from its utility. The index gives merely the headings of the memoirs or articles, omitting all details,—a serious defect in a work containing a mass of information at once so important and so varied. We should beg to suggest the publication—say once in ten years—of a general index of subjects.

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in Owens College, Manchester. Vol. ii., Metals (Part i). London: Macmillan and Co.

This volume opens with a consideration of the generic properties of the metals. The authors, we find, take a well-founded objection to the term "metalloid," still applied by some writers to non-metallic bodies, and insist on the absence of any distinct line of demarcation between the two great classes of elementary substances, not a few of which are alternately pronounced either metallic or non-metallic, according to the point of view whence they are considered. The remarks on alloys, though necessarily

brief, bring into prominence several facts often overlooked. After discussing the specific gravity of metals, their melting-points, atomic heats, and quantivalence, the authors pass to a consideration of the general properties of acids, the constitution of salts, &c. The metals and their compounds are then described in succession, according to the classification given on p. 22.

The present work is one of the very few chemical treatises in which the peculiar and unpleasant odour of potash-lye, so well known to practical men, is mentioned, though no light is thrown on its origin. In treating of the commercial sources of potash-salts, the manufacture of beet-root and cane-sugar is mentioned as a fortunate discovery. We cannot help regarding it as a serious mistake, which, if persevered in, must lead to the exhaustion of the soil.

Sodium and its compounds are described in considerable detail. The great English beds of rock-salt at Northwich, generally said to occur in the new red sandstone, are here described as found in the mountain limestone. It is noted that the process of evaporating brine, as followed in Cheshire, has not been improved since the times of the Romans. The alkali manufacture (Leblanc's process), as now carried on, is very fully described, and admirably illustrated with drawings done to scale. The recent improvements, proposed or actually carried out, are not omitted. Thus we have notices of Deacon's closed roasters for preventing the escape of hydrochloric fumes, of the mechanical salt-cake process of Messrs. Jones and Walsh, of Middlesborough, intended to obviate all hand-labour, and of the salt-cake furnace of Messrs. Cammack and Walker, which is declared to be based upon a more scientific view of the decomposition than any former plans, though at the same time no opinion is expressed as to its practical feasibility. The Hargreaves process for decomposing salt directly with sulphurous acid, in presence of air and steam, is also described. Mr. Mond's process for the recovery of sulphur from the vat-waste is noticed, as also the ammonia-soda process of Dyer and Hemming, which, as latterly improved by Solvay, is now worked on the large scale.

Under Calcium we find a description of the manufacture of bleaching-lime, with an account of Weldon's process, and of the improved chamber devised by Mr. Deacon. We do not see any mention of the revolving process recently invented, and said to give remarkably uniform results.

The authors enter at some length into the metallurgy of zinc, lead, copper, silver, and mercury, giving carefully executed drawings of the requisite furnaces. The electrotyping process is also described, without any reference to the share of the late Mr. Smee in the early development of the art. Electroplating and photography are noticed, though necessarily in brief compass.

Aluminium in the metallic state is a curious instance of a discovery from which great hopes were entertained proving subsequently a practical failure. Two interesting facts not generally known are mentioned in this chapter—the resuscitation of the ancient and renowned alum-works of La Tolfa by a French company, and the cessation of the manufacture of ammonia-alum. Some ten or twelve years ago it was often difficult to meet with a sample of potash-alum.

The volume before us merits and will receive the same favourable reception which was awarded to its predecessor. To the chemical student it offers the great advantage of bridging over the gulf between theory and practice better than probably any other text-book in the language. To manufacturers, foremen, &c., it would be of equal service for the same purpose were it not for the exclusive use made of the so-called "new" nomenclature. Had it been desired to keep practical men in the dark concerning chemical principles, and to produce confusion by the multiplication of synonyms, we doubt if a more successful method could have been adopted than this change of terminology.

CORRESPONDENCE.

THE BAND-PATTERN IN ANIMALS.

To the Editor of the Monthly Journal of Science.

Sir,—May I ask if any readers of the "Journal of Science" have made observations bearing on the curious fact that in a multitude of species belonging to different parts of the animal kingdom the colours are arranged, in bands or stripes, approximately at right-angles to a line drawn from the head to the tail? Further, in a vast majority of cases, these bands are alternately yellow and black, or at least a very deep green, deep purple, &c. This pattern prevails, among mammals, in the tiger and the zebra; among Hymenopterous insects, in a number of bees and wasps. But among the Coleoptera it recurs in a multitude of groups differing widely in their habits, localities, and affinities. Thus among the so-called "long-horns" we find it in the genera *Clytus*, *Rhagium*, *Stenura*, and *Diastocerus*; among Buprestids it occurs in *Cyria*, *Diadoxus*, *Nascio*, *Conognatha*, *Stigmodera*, and *Buprestis*. Among the Cetoniadæ it is met with in *Plæsiorhina*, *Anisorrhina*, *Allorrhina*, *Clinteria*, *Gametis*, *Pachnoda*, and *Euphoria*. It may finally be traced among the highly carnivorous tiger-beetles (*Cicindela*), and in the carrion-feeding sexton-beetles (*Necrophorus*). In all these cases, save the moths, the bands consist alternately of yellow, orange, or buff, and of black or some very dark shade. A few of these instances, such as those of the tiger and zebra, may subserve the purpose of concealment; and others, *e.g.*, *Clytus arietis*, may be mimetic, causing the insect to be mistaken for some more formidable species. But in the majority it seems as if we encounter here the markings of some more deeply-hidden law.—I am, &c.,

J. W. S.

THE SEA-SERPENT.

To the Editor of the Monthly Journal of Science.

Sir,—I have read with much interest your notice of Dr. Wilson's memoir on sea-serpents, and quite agree with you and with him that the question of their existence should be fairly and dis-

passionately discussed by biologists. With your permission, however, I will make a few remarks on the case of the *Pauline*. If the narrative deposed to at Liverpool is literally true, all doubt is at an end. No giant seal, basking-shark, piece of floating wreck, sea-weed, or flight of birds could act as the unknown monster is said to have done. The testimony—that of a number of disinterested observers who watched the struggle for a quarter of an hour—is such as would be accepted in any court of justice in the most serious case. Still there are certain points on which further light would be very welcome. When a boa or python attacks a deer its dry scaly surface is pressed against the rough hairy coat of the quadruped, whose limbs, further, prevent the deadly coils from slipping from their place. The sea-serpent, on the contrary, has to apply its skin, probably slimy, to the exceedingly slippery surface of the whale, where there is no neck, waist, or projecting limb to aid in retaining the folds. Would not the difficulty of killing by constriction be greatly enhanced under such circumstances? Again, the serpent whilst grappling with the whale is described as having its own head and tail disengaged, to the extent, as I understand, of 30 feet at each end. Now non-poisonous serpents, in attacking, invariably either keep hold of some fixed object with their tail, or lay hold of the intended victim with their jaws. As no fulcrum for the tail was possible in this case, I should think that a preliminary seizure with the mouth would be all the more essential. That the jaws must be capable of opening wide enough for this purpose is evident if the prey was afterwards to be swallowed. A "large" sperm whale measures in girth about 17 metres. It is much to be regretted that no naturalist appears to have had a conversation with the crew of the *Pauline*.—I am, &c.,

SERPENT-HUNTER.

PROCEEDINGS OF SOCIETIES.

ROYAL SOCIETY, *January* 9.—The first paper was a "Note on the Inequalities of the Diurnal Range of the Declination Magnet as recorded at the Kew Observatory," by Balfour Stewart, F.R.S., and William Dodgson. The authors are at present engaged in searching for the natural inequalities of the above range, more especially for any of which the period is between 24 and 25 days. They have found strong evidence of an inequality of considerable magnitude of which the period is 24·00 days, very nearly. They have also found preliminary evidence of the existence of two considerable inequalities having periods not very far from 24·65 and 24·80 days. These two appear to come together in about eleven years, but the exact time of this cannot be given. No trace of any inequality with a period of 24·25 days has been fouud. We shall give a report of a more recent paper on this subject in our March number.

"Some Experiments on Metallic Reflexion," by Sir John Conroy, Bart., M.A. The author finds that when light is reflected from a polished surface of gold or copper in contact with various media, the angle of principal incidence diminishes, and the principal azimuth increases with the increase of the refractive index of the medium in contact with the metallic surface; and further, the diminution in the value of the principal incidence appears to be nearly in proportion to the increase of the refractive index of the surrounding medium. The values of these angles for gold with red light are—

	Principal Incidence.	Principal Azimuth.
In air	76° 0′	35° 27′
In water	72 46	36 23
In carbon bisulphide ...	70 03	36 48

Assuming that the angle of principal incidence for a metal is the same as the angle of polarisation of a transparent substance, —that is, the angle whose tangent is equal to the refractive index,—the value of that angle in air, as deduced from the measurements made in water and carbon bisulphide by multiplying the tangent of the principal incidence in those media by their refractive indices, is 76·53 and 77·22 instead of 76.

"Researches on the Absorption of the Ultra-Violet Rays of the Spectrum by Organic Substances," by W. N. Hartley, F.Inst. Chem., F.R.S.E., F.C.S., and A. K. Huntingdon, F.Inst. Chem., A.R.Sc. Mines, F.C.S. The authors find that—

1. The normal alcohols of the series $C_nH_{2n+1}OH$ are remarkable for transparency to the ultra-violet rays of the spectrum, pure methylic alcohol being as nearly so as water.
2. The normal fatty acids exhibit a greater absorption of the more refrangible rays of the ultra-violet spectrum than the normal alcohols containing the same number of carbon atoms.
3. There is an increased absorption of the more refrangible rays corresponding to each increment of CH_2 in the molecule of the alcohols and acids.
4. Like the alcohols and acids, the ethereal salts derived from them are highly transparent to the ultra-violet rays, and do not exhibit absorption-bands.

In order to ascertain whether isomeric bodies exhibited similar or identical absorption-spectra, a series of benzene derivatives was examined. The results may be summarised as follows:—

1. Benzene, and the hydrocarbons, the phenols, acids, and amines derived therefrom, are remarkable—first, for their powerful absorption of the ultra-violet rays; secondly, for the absorption-bands made visible by dissolving them in water or alcohol, and diluting; and thirdly, for the extraordinary intensity of these absorption-bands,—that is to say, their power of resisting dilution.
2. Isomeric bodies, containing the benzene nucleus, exhibit widely different spectra, inasmuch as their absorption-bands vary in position and in intensity.
3. The photographic absorption-spectra can be employed as a means of identifying organic substances, and as a most delicate test of their purity. The curves obtained by co-ordinating the extent of dilution with the position of the rays of the spectrum absorbed by the solution form a strongly-marked and often a highly characteristic feature of many organic compounds.

There is a curious feature in connection with the position of the absorption-bands; at the less refrangible end they either begin at line 12 Cd or line 17 Cd, and those which begin at 12 end a little beyond 17.

"On the Electromagnetic Theory of the Reflection and Refraction of Light," by George Francis Fitzgerald, M.A., Fellow of Trinity College, Dublin. The author shows that the method adopted in his former paper on Magnetic Reflection, in the "Proceedings of the Royal Society" for 1876 (No. 176), is justified, and that it is legitimate to consider an incident plane polarised ray as composed of two oppositely circularly polarised rays, each of which is reflected according to its own laws. He considers next the cases of the magnetisation being all normal to the surface, and all in the surface and the plane of incidence, and

obtains the following result:—When the incident ray is plane polarised, and the plane of polarisation is either in or perpendicular to the plane of incidence, the effect of magnetisation is to introduce a component into the reflected ray perpendicular to the original plane of polarisation, which vanishes at the grazing and normal incidences, and, in the case of iron, attains a maximum at about the angle of incidence $i=63°20'$. He does not obtain any change of phase by reflection in any case. Apart from this question of change of phase, his results conform completely to Mr. Kerr's experiments on the reflection of light from the pole of a magnet.

CHEMICAL SOCIETY, *January* 16.—Dr. J. H. Gladstone, F.R.S., President, in the chair.

The first communication was made by W. H. Perkin, F.R.S., "On the Action of Isobutyric Anhydride on the Aromatic Aldehyds." The author has studied the reaction which takes place when isobutyric is substituted for butyric anhydride.

The next paper was by Dr. Dupré and H. Wilson Hake, "On Two New Methods for the Estimation of Minute Quantities of Carbon: (1) Gravimetric; (2) Chromometric; and their Application to Water Analysis." (1) The Gravimetric Method:—This method consists essentially in burning the small quantity of carbon in a stream of oxygen in an ordinary combustion-tube containing some granulated cupric oxide. The method is found to be quite accurate enough for determining the carbon obtained from a litre of a first-class potable water. The chromometric method, or, as the authors name it, the nephelometric method, consists essentially in burning the carbon, but the carbonic acid is conducted into a standard solution of basic acetate of lead, and estimating the turbidity produced, as compared with that produced by the carbonic acid evolved under similar circumstances by a known and nearly equal quantity of carbon, the difference between the two being estimated by a Mills's colorimeter. This method is extremely delicate, and a difference produced by 3-100ths of a milligrm. can be clearly estimated. The authors suggest their use for estimating the carbon in iron and the carbonic acid in air.

Dr. Frankland read a communication "On Stannic Ethide," by E. Frankland and A. Lawrance. In endeavouring to prepare stannous ethide by the action of zinc ethyl upon dry stannous chloride the authors discovered that the reaction was—

$$2SnCl_2+4ZnEt_2=Sn+SnEt_4+4ZnEtCl,$$

and that by its means stannic ethide could be prepared more conveniently and in larger quantities than has hitherto been possible.

The next paper was by R. S. Dale and C. Schorlemmer, "On Aurin," Part II. In previous researches the authors stated that by the action of alcoholic ammonia on aurin, rosanilin was

obtained, and a dilemma arose, that if aurin had the formula $C_{20}H_{14}O_3$, rosanilin could not have the formula which Hofmann had proved it to have, $C_{20}H_{19}N_3$. The authors therefore again prepared pure aurin and confirmed their previous analysis. Zulkowsky states that the method employed by the authors yields wretched results, and cannot be used on the manufacturing scale. The authors, however, affirm in the present paper that under certain conditions, which they are not at liberty to divulge, a fairly good yield can be obtained. They have used two methods to purify aurin; one by conversion into ammonia aurin and the decomposition of the latter by hydrochloric acid, and a second by taking advantage of the fact that the solubility of aurin in alcohol decreases with the removal of the by-products. The analyses of pure aurin thus obtained completely confirmed the formula $C_{20}H_{14}O_3$. Some beautiful specimens were exhibited in connection with this paper.

A paper was read by W. Carleton Williams "On the Derivatives of Di-isobutyl."

The last paper was "On the Action of Chlorine upon Iodine," by J. B. Hannay. The author has re-examined the question as to the existence of the compound ICl_4, and has come to the conclusion that such a body has no existence, for two reasons. First, that the reaction for its formation is impossible, as no high chloride of iodine can exist in the presence of free iodine; and, secondly, that careful experiments by which chlorine is added to iodine in the most advantageous manner for the formation of a high chloride fail to indicate such a body,

Meteorological Society, *January* 15.—The annual meeting of this Society was held at the Institution of Civil Engineers—Mr. C. Greaves, President, in the chair.

The report of the Council showed that the chief features of the proceedings during the year 1878 had been the final completion, on a comprehensive and well-organised basis, of the arrangements for systematic inspection of the Society's stations—an object which has engaged the sedulous attention of successive Councils for the last four years—and the delivery of a series of lectures on meteorology by certain members of the Council. The total number of Fellows now amounts to 425, 41 having been elected during the year.

The President having delivered his address "On Dryness versus Humidity," the Officers and Council for the ensuing year were elected.

January 18.—The usual monthly meeting of this Society was held at the Institution of Civil Engineers The following papers were read:—Abstract of "The Meteorology of Bombay Presidency," by C. Chambers, F.R.S., communicated by Sir G. B. Airy, K.C.B., F.R.S., Astronomer Royal. "Experiments with Lowne's

Anemometer," by Captain William Watson, F.U.S.; "Meteorology of Bangkok, Siam," by J. Campbell, Staff-Surgeon, R.N.; "Results of Meteorological Observations taken at Calvenia, South Africa," by Kaufmann J. Marks, F.U.S.

PHYSICAL SOCIETY, *January* 15.—Prof. G. C. Foster, Vice-President, in the chair.

Dr. Erck exhibited a constant bichromate of potash battery. It consists of a narrow lead trough, 12 ins. long by 3 ins. wide and 1 in. deep, lined along both sides with the carbon plates. The zinc plate, 10 ins. long, is immersed in the solution to the depth of an inch midway between the two carbons. A continual circulation of the bichromate solution is kept up by allowing fresh solution to drop into the cell at one end, and the exhausted solution to drop away by a tap at the other end. As the space between the two carbons is only about half an inch wide, there is merely a thin layer of solution between the positive and negative poles. The internal resistance of the cell is therefore very low when short circuited, only about $\frac{1}{4}$ ohm. To obtain the maximum current, about 8 ozs. of solution per hour should be supplied.

Dr. Guthrie, F.R.S., described some of the results he had obtained from experiments on the vibration of metal rods or lathes fixed in a vice at one end and free to vibrate at the other. The experiments were carried on by dusting sand on the rod and observing the nodal lines formed by it when the rod was vibrated so as to give out notes determined by a monochord. Dr. Guthrie's results showed that the two final segments at the free end are equal in length to the inner segment at the fixed end. It appears from these experiments that if a free lathe, vibrating with a node in the middle but having an even number of segments, be clamped at where there is a node we alter its conditions of vibration. When the lathe is half free the end segment breaks up into two parts together equal to the segment at the fixed end. In the case of torsional vibration of the lathe the position of the longitudinal nodal lines depended to some extent on the clamping of the lathe in the vice.

Prof. Foster pointed out that in a natural node the direction of the tangent is varying, whereas in an artificial node it is always horizontal.

Prof. Unwin explained that the sand accumulated at nodes because the particles when thrown off the lathe make certain horizontal excursions, which tend to move them nearer the points of repose of the lathe.

NOTES.

Agriculture.

The *Phylloxera* Commission of the French Academy have resumed their labours after having suspended them for two years. They have been roused into action by the increased ravages committed on French vines during the last summer and autumn. The Minister of Agriculture has allowed the Commission a certain sum for expenses. Let us hope that their present labours will be more fruitful than their former ones.

Biology.

The blood of the Octopus contains—instead of hæmoglobin—hæmocyanin, an organic compound containing copper, which here assumes the function fulfilled by iron in the circulation of the Vertebrates.

The chestnut trees of the Cevennes are perishing in consequence of their roots being attacked by a fungus. The tannic acid present in the juices of the trees exudes, and forms black stains on the trunks and on the surface of the soil, whence this new epidemic is locally known as *Maladie de l'encre*.

The celebrated botanist F. Cohn, in speaking of *Anastatica Jerochontica*, said, "The rose of Jericho,"—which, in the first place, is not a rose, and which, secondly, is not found near Jericho.

The well-known butterfly *Colias Edusa* (clouded yellow), which was in 1877 more plentiful in England than ever before, has been last year as remarkably and exceptionally scarce.

M. V. D. Costes, in the "Correspondance Scientifique," suggests that ants have already passed through their stage of social progress, and, having reached the highest perfection consistent with their faculties, have now become stationary, and incapable of further advance.

According to Mr. F. P. Pascoe (Entom. Mo. Mag.) a new species of *Siderodactylus* is ravaging vines in the Island of Ascension. It seems to have been imported from South Africa.

M. L. Fredericq, in a paper communicated to the Academy of Sciences, maintains that the changes of colouration in the skin of the Octopus have no correspondence with the facts of mimetism, and resemble rather the changes produced in the human face by the emotions of fear or anger.

M. Dareste has experimented on the suspension of life in the embryo chicken. He finds that in eggs taken from under a hen

after three days' incubation, and exposed to the temperature of the atmosphere, which was then 20° C., the movement of the heart was not completely arrested until after the lapse of seven days.

Haltica nemorum, a tiny yellow-striped beetle, proves to be an enemy to barley.

Prof. Turner, of Edinburgh, in his Memoirs on the "Comparative Anatomy of the Placenta," points out essential differences between the structure of this organ in the sloth and in the lemurs, especially in the *Protopithecus* of Madagascar.

M. Bordier considers atmospheric pressure as one of the principal agents in the transformation of species.

According to M. P. Bert the periodic movements of plants and their heliotropism are due to variations in the quantity of glucose contained in the moving part, in consequence of its state of hydration and its consequent degree of tension.

Prof. Haberlandt considers that the chlorophyll in the cotyledons of *Phasiolus vulgaris* is formed from starch. The starch-granules are gradually surrounded with a layer of protoplasma, which is at first colourless, but gradually turns green, while the starch grains disappear.

M. Yung has communicated to the Academy of Sciences the results of his experiments on the action of different coloured light upon the development of animal ova and larvæ. Their action, beginning with the most favourable, may be arranged thus:—Violet, blue, red, yellow, white, green. The red and green light appeared positively hurtful. Between yellow and white light there was little difference. Tadpoles kept without food died most quickly in the violet and blue rays. The incidental mortality appeared greater in the coloured rays than in white light.

Chemistry and Technology.

Wines on analysis often display properties not suspected from their taste. Sorts rich in alcohol are often pronounced light, and others strongly acid seem mild, &c. These seeming contradictions are, according to Drs. Mach and Patele, due to the fact that wine is a most complicated liquid, whose components are by no means all known. Even among the recognised and more prominent ingredients, it is not so much the quantity of one or the other as their relative proportion which determines the flavour.

Some new phenomena observed in "plastering" wines and musts are recorded by Prof. E. Pollacci. He finds sulphate of lime reacts solely upon the cream of tartar, producing acid sulphate of potassa, which remains in solution, while tartrate of lime is formed and is chiefly deposited. The reaction between

the two salts is not, however, complete, since there may be found in the liquid both sulphate of lime and cream of tartar. If the gypsum is in large excess a part of it is deposited among the tartrate of lime.

Dr. Theodor Schuchardt, of Goerlitz, has introduced a new body, which he calls silicium strontium. It is formed from the preparation of metallic strontium by electrolysis. The compound is a grey powder with a slight odour resembling phosphuretted hydrogen. When mixed with dilute hydrochloric acid a rapid evolution of the spontaneously inflammable siliciuretted hydrogen takes place. If obtainable in quantity this compound will probably be the readiest source of siliciuretted hydrogen.

A ready means of detecting the adulteration of saffron is suggested by Messrs. Domeier and Co. To detect adulteration with *Calendula* flowers (Feminelle) it is merely required to moisten a few flowers, and to rub them singly with the finger on white paper. The genuine flowers will give a fine rich yellow colour, whilst the Feminelle will only yield a violet reddish hue. It can also be easily detected by soaking the suspicious flowers in pure —or, better still, distilled—water. The real saffron will retain its fine red colour after hours, whilst the Feminelle will lose its artificial tint within a short time. To detect an admixture of honey and barytes it is merely required to put a pinch of saffron in a tumbler with pure clear water, agitating it for a few minutes. Adulterated saffron will at once turn the water cloudy, and even small particles of dust may be seen falling to the bottom, which, on pouring the water carefully out, will be found to be a slimy, sand-like mass. With pure saffron the water will remain clear, showing a fine pure yellow colour, which, according to the quality of the flowers, will be more or less intense. Five or ten minutes suffice for these experiments.

Metallurgy.

An admirable sketch of the present position of the French Iron-trade, drawn up by M. S. Jordan, Professor of Metallurgy at the Ecole Centrale, for the use of his foreign colleagues at the Paris meeting of the Iron and Steel Institute, is given in the October number of the "Revue Universelle des Mines." It begins by describing the different French coal-basins. The iron-ores native to France are then described, and the analyses of most of them are given. We are next presented with a series of tables showing the consumption of French ores both native and foreign. The smelting processes also receive attention, and are described in eleven geographical groups.

Physics.

Mr. Louis Schwendler has reported to the India Office on the suitability of the electric light for India. We shall refer at length to this report in our next number; meanwhile we may

mention that Mr. Schwendler advocates the employment of the electric light at Indian railway-stations.

The German Government lost no time in the practical employment of the telephone. There are now 272 telephonic circuits, and communication is satisfactorily carried on over a distance of from 30 to 40 miles.

Mr. Stroh, the well-known mechanician, has observed that if a telephone, with the circuit of its coil left open, be held to the ear, and a powerful magnet be moved gently up and down along the length of the magnet, and at a distance of an inch or two from it, a faint breathing sound will be heard; the recurring pulses of sound keeping time with the up and down motion of the magnet. The sound may, according to the "Telegraphic Journal," be aptly compared to the steady breathing of a child, and there is a striking resemblance between it and the microphonic sounds of gases diffusing through a porous septum, as heard by Mr. Chandler Roberts, F.R.S.

Writing on the subject of Gas *versus* Electricity, to "Nature," Mr. W. H. Preece observes that we know no more of the electric light now than we did in 1862, when as great a display was made in our Exhibition of that year as was made in the French Exhibition of last year. The recent experiments have, he says, shown both the strength and weakness of the position of the gas companies. Their strength consists in their being in possession of the ground; their weakness consists in their producing only a poor light—and a very poor light—when compared with electricity. But it would almost seem, from the experiments that have been made, that the quantity of light to be produced by gas is only a question of the quantity of gas consumed in a given space. There are now burning in the Waterloo Road two brilliant gas-lamps, giving a light of 500 candles; and this is greater, in point of fact, than the intensity of the light developed by any one of the electric lights that are now on trial in the thoroughfares of London. There is, however, a defect in gas light which remains to be eradicated, and that is the colour of the light. The one great advantage which the electric light has over gas is that the electric light, owing to its very high temperature, produces rays of every degree of refrangibility, and therefore as an illuminating power it is equal to that of the sun. A very marked advance towards perfection in this direction in gas-lighting has been made in the albo-carbon process, by which the gas burnt is enriched with the vapour of naphthalin—a refuse of gas manufacture. By this process the intensity of the light of a gas-burner is improved at least five times, and in some experiments witnessed by Mr. Preece the improvement was as much as twenty times. There are three points which all electric lights for general purposes should be required to attain: the first is a brilliancy far exceeding that of any known lamp; the second is

a durability greater than that which would be required for night operations in England; and the third is absolute steadiness, to enable work to be conducted without affecting the eyes. There is no electric light that has yet been introduced which supplies us with these desiderata.

The first of the Friday evening discourses, at the Royal Institution of Great Britain, was given on the 17th ult., by Professor Tyndall, his subject being "The Electric Light." The electric light had, he said, been known for seventy years, as in 1808, and again in an improved form in 1810, it was shown to audiences at the Royal Institution. Prof. Tyndall quoted Faraday's saying, that he would rather occupy himself with finding fresh effects than spend his time in exalting those effects. But it was the exaltation of these effects which he first studied in a simple way which has led to the present possibilities of our electric lighting. Prof. Tyndall gave a historical sketch of the various arrangements, beginning with that of Mr. Holmes in 1862. The different "candles" in use were also described. Prof. Tyndall said he did not believe any fresh scientific discovery was needed to make the electric light of general application to large places. The scientific man knew what different natures of machines were required to do the different kinds of work to be done. It remained now for mechanical skill to carry out the work. In conclusion he pointed out the mistake of those who, like Cuvier, spoke with contempt of those whose practical skill carried to utility the experiments of the philosopher.

The Philosophical Society of Glasgow have instituted a triennial lecture in memory of the late Prof. Graham, Master of the Mint. The Council have also caused a portrait medal of the value of £10 to be struck, and this they propose to award every third year for the best original investigation, either in chemical physics or in pure or applied chemistry, which may be communicated to the Society or to its chemical section in the interval of the awards. The choice as first Graham Lecturer appropriately fell on Mr. W. Chandler Roberts, F.R.S., who had so long been associated with Graham's work, and who was enabled to employ much of his original apparatus. The lecture was given on the 22nd ult., Mr. James Young, F.R.S., presiding. Mr. Roberts described in detail the experiments that enabled Graham to establish the law of the diffusion of gases, and he illustrated experimentally the passage of gases through porous bodies, such as unglazed earthenware and artificial graphite, as well as through a layer of the hard translucent variety of opal known as hydrophane. Mr. Roberts pointed out that the Graham law of diffusion forms the basis of the science of molecular mechanics, and his measurements of the rates of diffusion prove to be the measure of molecular velocities which have been investigated mathematically by Clerk Maxwell, Clausius, and Boltzmann, and experimentally by Losehmidt in developing the dynamical theory of gases.

The liquefaction of gases formed the subject of Graham's earliest paper in 1826, and it occupied his attention at intervals during his life. He held the view that hydrogen, when absorbed by palladium, is reduced to the metallic form—a supposition which has received strong confirmation from the success that has attended M. Raoul-Pictet's efforts to solidify this gas. At the conclusion Mr. Roberts said the Graham lecture had been instituted in honour of the labours of a life the memory of which will be as enduring as its work, and to stimulate others to investigate as patiently and earnestly the varied phenomenon whose basis is molecular mobility.

Mr. F. H. Ward, F.R.M.S., has endeavoured to get rid of the objectionable black lines across the spectrum caused by dirt adhering to the jaws of the slit, by substituting a right-angled prism with the apex of the right angle carefully ground off and polished, forming what he terms a solid slit. With glass prisms, although it answered well for bright line spectra, it was an entire failure so far as continuous spectra were concerned. The spectrum was as full of lines as with a very dirty slit. The cause was evident upon microscopical examination, the edges being splintered. Better results were obtained with quartz prisms, which promise well when more skill is obtained in polishing the very delicate edge.

The value of telescopes for viewing objects at short distances appears to have been overlooked. The writer frequently employs a telescope for examining plants on cliffs, in ponds, and other inaccessible places at distances as small as 15 ft. The effect is almost microscopic, details of flowers and venation of leaves being clearly brought out. The instrument is a small one by Ross, having an object-glass of 1·35 ins. aperture and about 12 ins. focal length, the ample length of slide allows such near objects to be distinctly focussed; while its more legitimate performance is all that can be desired, and its corrections perfect enough to allow many celestial objects to be seen, bearing well a tolerably deep eye-piece.